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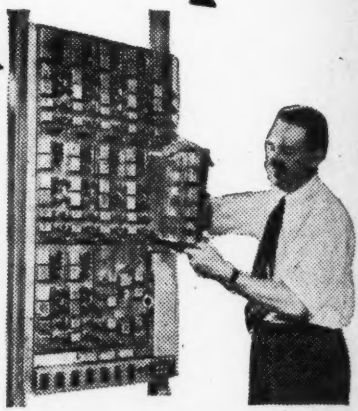

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Solomon Cady Hollister, President, A.S.E.E., 1951-52

The newly elected President of the Society has been engaged almost equally in both the practice and the teaching of engineering. Although the past twenty years have brought him a succession of academic assignments, culminating in his appointment as Dean of the College of Engineering at Cornell University in 1937, he has continued in this period his early association with professional practice and development. His concern with the advancement of the engineering profession is evident in his expressions of educational philosophy, particularly in his insistence that today's education must be strengthened to support the advanced technology of two or three decades hence.

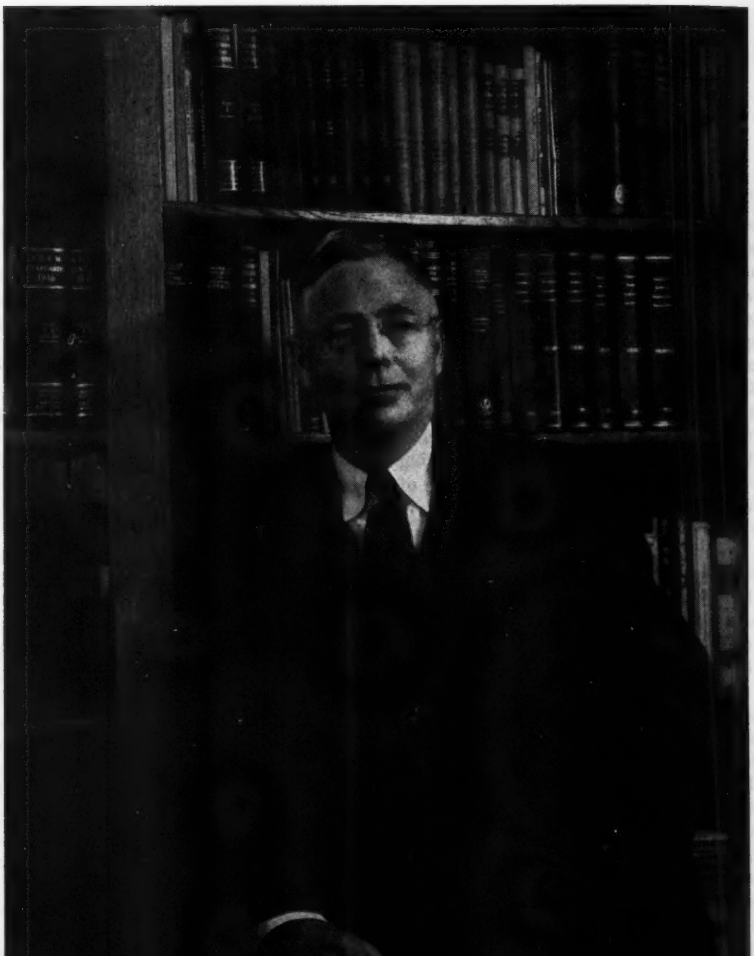
Dean Hollister's own collegiate training was undertaken at the State College of Washington, and at the University of Wisconsin, where he received the B.S. in C.E. in 1916 and the C.E. in 1932. He was awarded the honorary degree of Doctor of Engineering at Stevens Institute of Technology in 1942.

For a period of fifteen years after graduation he engaged in a wide range of professional practice. It was at this time that reinforced concrete construction was emerging from the status of a somewhat unpredictable art to that of a structural science. Dean Hollister soon became associated with several of the major activities in this field, including in his work the post of chief design engineer on the development of concrete ships for the U. S. Shipping Board in World War I. Although his career has since taken him into various other engineering interests, he has maintained a close affinity with concrete technology as a teacher, consultant, and member of numerous technical groups in the field. He has served as a member of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. His long association with the American Concrete Institute includes several committee chairmanships and two terms as president, 1932–34.

Of his many publications, a good number deal with concrete and structural design, including A.C.I. Wason Research Medal paper, "Design and Construction of a Skew Arch Bridge." He has also contributed sections on these subjects for several engineering handbooks.

As a consulting engineer in the 1920's, he became interested in the potentialities and problems of structural welding. He undertook the development of the more rigorous methods of stress analysis and engineering control required in welded fabrication. This interest in turn led him back to the academic scene at Purdue where, in 1930, he accepted appointment as Professor of Structural Engineering and Assistant Director of the Testing Materials Laboratory. His work on photoelastic methods of analysis led to his appointment as consulting engineer to Babcock and Wilcox on the design and fabrication of the Hoover Dam penstocks. He has since carried out a number of assignments for this company on high pressure boiler design. Other consulting activities with industry and government agencies have covered a wide range of engineering problems.

In 1934 he came to Cornell as Director of the School of Civil Engineering, and in 1937 he was appointed Dean of the College of Engineering. He has since devoted much time to educational



SOLOMON CADY HOLLISTER, PRESIDENT

development, and particularly to the relation of engineering education to the profession. For the past two years he has been chairman of the Education Committee of Engineers' Council for Professional Development, and chairman of the Subcommittee on Graduate Education. His affiliation with A.S.E.E. dates back to 1916 and includes service as chairman of the Administrative Division (S.P.E.E.) and of the Committee on Universal Military Training (S.P.E.E.), member of the Manpower Committee, and member of Council (1937–40).

For the past several years Dean Hollister has been active in focusing attention on the impending shortage of engineers. He is presently serving as a member of the Engineering Manpower Commission of Engineers Joint Council; the Advisory Committee on Engineering Sciences for Selective Service; and the Committee on Specialized Personnel, Office of Defense Mobilization.

Dean Hollister is a member of a number of professional societies, including A.S.C.E., which he served as a director, A.S.M.E., A.R.E.A., and others, and of Sigma Xi, Tau Beta Pi, Phi Kappa Phi, Chi Epsilon, and Gamma Alpha. His public service has included the chairmanship of the Advisory Committee on Water Resources of the State of New York; membership on the Governor's Advisory Committee on Technical Industrial Development; consultant to the U. S. Maritime Commission; and Regional Director for ESMWT during the war years. He is at present a member of the Advisory Committee to the U. S. Coast Guard Academy.

Fall Meetings **Fall Meetings**

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

including

ENGINEERING COLLEGE ADMINISTRATIVE COUNCIL
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GENERAL COUNCIL

November 15, 1951 **Rice Hotel, Houston, Texas**

The ECAC along with the ECRC and the General Council will hold meetings at the Rice Hotel, Houston, Texas, Thursday, November 15, at 2:00 P.M. These meetings will immediately follow the annual meeting of the Association of Land-Grant Colleges and Universities, which will be held at the Rice Hotel from Monday, November 12, until Thursday noon, November 15, inclusive. This arrangement is for the benefit of many of our members who also belong to the Land-Grant College Association.

President Hollister will open the meeting, outlining the need for such guidance activity.

The Year of Evaluation

By S. C. HOLLISTER

President, ASEE and Dean of Engineering, Cornell University

It seems appropriate, in this first year of the second half of this century, that we take account of our progress in engineering education through an objective evaluation of our performance; and that we appraise the engineering profession to determine whether its growing needs are being adequately met.

Fifty years ago, at the turn of the century, the steam turbine was just emerging. Although electricity was an established source of power, it had not yet gained its eventual place in industry; and the household appliance was far in the future. The automobile was scarcely to be trusted on a trip the length of Main Street, and if one wished to venture farther, he found there were no decent roads. The X-ray was very new and the airplane and radio-telegraph were yet to come. The telephone was a box on the wall. Kerosene was still widely used for lighting. The petroleum and chemical industries were only beginning. The first steel bridge was about twenty years old.

Although there were at that time about 110 schools teaching some phases of engineering, only a few would be considered as being strong. There had emerged by that time, however, the general form of curriculum that during the following decade became generally adopted. That these early curricula furnished strong support for the profession in bringing into being the many engineering achievements of those times is understandable, since these achievements were largely first approximations, made with a wealth of natural material resources upon which to draw. Because of their widespread adoption as to both form and content, these curricula became standard; and certainly in the older branches of civil, mining, mechanical and electrical power engineering, the curricula have in most schools been modified very little in the last forty years.

The educational system that has come into being in this country certainly was not evolved after a preconceived national plan, so far as engineering and allied fields are concerned. Whereas abroad there is commonly a technical institute program functioning in parallel with strong professional engineering education, there have been relatively few technical institutes in this country, leaving the burden of serving both needs upon the engineering schools. Moreover, engineering curricula developed as substitutes for, rather than extensions of, general collegiate education, and thus did not follow the evolution of education in the medical and legal professions.

During the periods between the two world wars the engineering schools were preoccupied with problems arising from this process of substitution. There was general agreement that more general education was needed. There were border fields into which some engineering graduates were going, such as management and commerce. It seemed to some that the engineering curriculum should somehow be made to stretch over all this range of education—and at the same time the length of the programs must not go beyond the traditional four years.

Some doubted the wisdom of trying to make the engineering curriculum serve so many objectives in so limited a time. It took the urgent demands of World War II to bring into focus once again

the fact that the *primary* function of the engineering school is to train engineers, and train them well.

And now, at this mid-century point, it is pertinent to ask some questions of ourselves. Just how well are we preparing engineers? Are we training them to perform a certain list of skills, or are we educating them in the fundamentals of a profession and inspiring them toward further self-development after "commencement"? Just how thoroughly and extensively are we giving them these fundamentals; and in the light of scientific advances are we giving them all they will need twenty-five years after they leave us? Have the technical needs of industry and the profession advanced and will they further advance during the next quarter century? Shall we be satisfied with a curriculum that was largely crystallized forty or more years ago, and if so, how can we make it serve? Should we look to scientists to enter the profession, to provide a dynamic and adequate growth?

We have but one duty: to serve the student so well that he will not be found wanting when called upon by his profession or his country. Are we performing this duty to our complete satisfaction?

I propose that we devote a major portion of our time during this year to a searching inquiry into these and other questions in the hope that as a Society we shall further advance our profession, in the interest of the progress of the students we serve.

In the News

New Issue of ECPD Guidance Manual Published

A guidance manual intended for engineers who are aiding young men interested in the engineering profession was recently published by the **Engineers' Council for Professional Development**, 33 W. 39th St., New York, N. Y. The 15-page pamphlet, prepared by the ECPD Guidance Committee, urges members of local engineering societies and sections and chapters of national engineering societies to establish guidance committees to aid high school pupils to determine whether they are qualified for careers in engineering. The present critical engineering manpower shortage emphasizes the need for guidance of the type indicated in this manual. The manual explains briefly how to organize advisory committees and how to select committee members. The manual contains suggestions for working with high schools and secondary schools students and lists aids especially useful in counseling high school boys. The guidance manual is supplemented by an appendix, "Shall I Study Engineering?" which is a questionnaire to be filled out by the student for use of the engineer who is advising him.

Is Less Than Graduation Worth While?*

By CLEMENT J. FREUND

Dean, College of Engineering, University of Detroit

"Well, good-bye, my boy. It's too bad it turned out this way. But pick up your courage; you have been working hard, and hard work will get you there, one way or another. Make a new start and your luck ought to be better. And best wishes, wherever you go and whatever you try."

There can hardly be a faculty man in the room who has not time and again gone through the painful business of shaking hands with a student who is quitting college. Perhaps the study of engineering has been the student's absorbing ambition ever since he was a small boy. Possibly his parents have spent their lives hoping, planning and working "to get him through" the college of engineering. He is sure to be a pathetic if not a tragic figure.

We engineers and engineering educators have always been concerned about the student who "drops out" or is "kicked out." The Report of Investigation of Engineering Education deplored the plight

"of the eighteen-year-old boy just emerging with his fondest dreams dashed to pieces, after his first disastrous experience with the elimination machine. . . ."[1]

And the Engineers' Council for Professional Development, in the Fifth Annual Report, insists that

"moral and psychological effects of failure are serious and real. The sense of defeat is a handicap at a critical period in the life of youth struggling for a foothold."[2]

Terminal Character of Faculty Concern

But if we take a good look at our concern for the student who is dropping out, we have to admit that it has what might be called a terminal quality. We are genuinely sorry because he will not graduate, but we quickly wash our hands of him the moment he departs. True, we are logical enough; it is our job to teach engineering students, and we can't teach them after they have gone. But our very logic puts to shame the boy who does not graduate, and marks him as a second-rater. Anybody who has doubts in the matter need only listen to the embarrassed, frantic apologies of the lad who has dropped out; or of his parents.

Furthermore, because the engineering curriculum of four or five years is an integral unit, we make it appear to the student, his parents and the public, that it has to be all or none, and that if he gives up after two or three years, he has utterly wasted so may years of his precious young life.

On the face of it, does not all of this seem wrong? Can anyone seriously contend that the student gains nothing whatever from learning, or trying to learn, the subject matters of even the freshman year, and from exercising the diligence, patience and determination which the learning process requires? Surely, the engineering student does not acquire all the values of a college education during the commencement exercises, as if in a package with his diploma; he absorbs them gradually as he goes along.

Besides, is it not altogether possible that there are students who should not go on to graduate? For all we know, two or three years of study may be more

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* Presented before the ECAC at the Annual Meeting of the ASEE, Lansing, Michigan, June 28, 1951.

[1] Society for the Promotion of Engineering Education, I, 208.

[2] (October, 1937) p. 11.

profitable and appropriate to their temperaments, talents, plans and career objectives. Indeed, I am personally acquainted with a number of gifted and highly successful men who completed only two years of the engineering curriculum, and never did intend to complete more.

Faculty Interest

The Engineering faculty in the University of Detroit has been much interested in all these conjectures—and conjectures are all that they have been. Some months ago we determined to find out, if we could, from non-graduating former students (hereafter called "former students") just what they think about the fragmentary education they have had. We mailed a carefully worded letter and a report form to approximately one in ten former students, selected at random from those who have left the University since 1930. The report form was really a questionnaire, but the word is in such evil repute that we used a different term.

We distributed 986 report forms, and 146 were returned undelivered. Hence, 840 former students presumably received the forms. 226 of these 840, or 29.6 per cent, filled out the reports and sent them back to us.

Questions

We proposed to ourselves a number of questions which bear on the problem of former students. These questions follow, together with data which the former students supplied in answer to each, and brief comment where comment appeared to be called for.

HOW MANY YEARS OF THE CURRICULUM DID THE FORMER STUDENTS COMPLETE? (Table 1)

TABLE 1

ALL REPORTING FORMER STUDENTS. PERCENTAGE DISTRIBUTION BY YEARS OF CURRICULAR COMPLETED

Completed one year	22.5%
Completed two years	47.8
Completed three years	18.6
Completed four years	8.4
Completed five years (Five year curricula in University of Detroit)	2.2
Completed more than five years	0.5

DID THE FORMER STUDENTS LEARN ENOUGH IN THE UNIVERSITY TO MAKE THEIR STUDIES, TIME, AND TUITION AND FEE PAYMENTS WORTH WHILE? (Table 2)

TABLE 2

ALL REPORTING FORMER STUDENTS. PERCENTAGE DISTRIBUTION BY OPINION CONCERNING VALUE OF STUDIES

Studies worth while	77.4%
Studies not worth while	17.3
No answer	5.3

This is obviously the very core of the discussion. What we really want to know is not if college studies did the former students any good (they could hardly harm them), but whether they would spend the time and the money if they had it to do over again.

These former students do not support the more or less common opinion among both teachers and students that those who fail of graduation have wasted all the months and years they spent in college.

HAVE THEIR COLLEGE STUDIES BEEN OF USE TO THE FORMER STUDENTS IN THEIR PRESENT EMPLOYMENTS? (Table 3)

TABLE 3

ALL REPORTING FORMER STUDENTS. PERCENTAGE DISTRIBUTION BY OPINION CONCERNING VALUE OF STUDIES IN EMPLOYMENT

Studies useful in employment	80%
Studies not useful in employment	16
No answer	4

We looked for this kind of result. Preparation for employment is, of course, one of the principal objectives of engineering education, and it should be no surprise to find that the majority of the former students have profited in their

jobs from even a portion of the curriculum.

IN WHAT KIND OF WORK ARE THOSE FORMER STUDENTS ENGAGED WHO REPORTED THAT THEIR COLLEGE STUDIES HAVE BEEN OF USE IN THEIR PRESENT EMPLOYMENTS? (Table 4)

TABLE 4

FORMER STUDENTS WHOSE STUDIES ARE USEFUL IN EMPLOYMENT. PERCENTAGE DISTRIBUTION BY KIND OF WORK

Engineering or technical, such as testing, estimating, heat treating, surveying, etc.	44%
Manufacturing or construction, such as production, contracting, maintenance, operating, inspection, time study, etc.	18
Business or commercial, such as bookkeeping, selling, advertising, banking, financing, etc.	20
Armed forces	5
Employment other than preceding	9
Unemployed	4

These data should raise questions in the minds of those of us who tell the student who is going to quit that he ought to stay out of technical and industrial occupations, and should "try banking or journalism or something."

WHAT PERCENTAGE OF ALL FORMER STUDENTS ENGAGED IN EACH KIND OF WORK HAVE FOUND THEIR COLLEGE STUDIES OF USE IN THEIR EMPLOYMENTS? (Table 5)

TABLE 5

ALL REPORTING FORMER STUDENTS. PERCENTAGE IN EACH KIND OF WORK WHO REPORTED STUDIES OF USE IN THEIR EMPLOYMENTS

Engineering or technical, such as testing, estimating, heat treating, surveying, etc.	99%
Manufacturing or construction, such as production, contracting, maintenance, operating, inspection, time study, etc.	89
Business or commercial, such as bookkeeping, selling, advertising, banking, financing, etc.	71
Armed forces	75
Employment other than preceding	64

It is noteworthy that former students consider their studies more or less useful according as technology is relatively more or less important in the kind of work they are doing.

IS THE VALUE OF COLLEGE STUDIES IN THEIR EMPLOYMENTS AFFECTED BY THE NUMBER OF YEARS OF THE CURRICULUM THE FORMER STUDENTS COMPLETED? (Table 6)

TABLE 6

ALL REPORTING FORMER STUDENTS BY YEARS OF THE CURRICULUM COMPLETED. PERCENTAGE COMPLETING EACH YEAR WHO REPORTED STUDIES OF USE IN THEIR EMPLOYMENTS

Completed one year	69%
Completed two years	84
Completed three years	81
Completed four years (Five year curricula in University of Detroit)	89

This is exactly what one would expect; studies are useful in employment approximately in proportion to the length of time spent in college. The logical inference, of course, is that it is better for the student to graduate than not to, as far as his job is concerned. But the issue here is whether less than graduation is of any value at all.

JUST HOW HAVE COLLEGE STUDIES BEEN OF USE TO FORMER STUDENTS IN THEIR EMPLOYMENTS? (Table 7)

TABLE 7

FORMER STUDENTS WHOSE STUDIES ARE USEFUL IN EMPLOYMENT. PERCENTAGE OF TOTAL REPORTING HOW STUDIES HAVE BEEN OF USE

Understanding of the principles of the physical sciences, mathematics, chemistry, physics	71%
Skill in drafting, computing, testing, use of instruments, etc.	58
Information about techniques, organization and practices of engineering, manufacturing, construction, etc.	38
Habits of accuracy and thoroughness, method of thinking, creative ability, etc.	71
Other than preceding	28

These data were especially pleasing to our faculty. If we have had any special and favorite purposes, these have been to impart comprehension of scientific principles and good work habits to the students, and the former students report that it is these purposes which we have most successfully accomplished.

HAVE THE FORMER STUDENTS BEEN HELD BACK IN THEIR EMPLOYMENTS BECAUSE THEY HAVE NO COLLEGE DEGREE? (Table 8)

TABLE 8

ALL REPORTING FORMER STUDENTS. PERCENTAGE DISTRIBUTION ACCORDING TO HANDICAP IN EMPLOYMENT BY LACK OF DEGREE

Held back by lack of degree	24.8%
Not held back by lack of degree	68.6
No answer	6.6

This result seems to make it clear that most of the former students have no regrets whatever about not graduating, at least as far as their jobs are concerned. And if they were to start their lives over again they would doubtless again leave college before earning their degrees.

HAVE PASSING YEARS AND CHANGING CONDITIONS HAD ANY EFFECT UPON THE USEFULNESS OF COLLEGE STUDIES IN THE EMPLOYMENTS OF FORMER STUDENTS? (Table 9)

TABLE 9

ALL REPORTING FORMER STUDENTS BY CALENDAR YEARS IN WHICH THEY LEFT THE UNIVERSITY. PERCENTAGE LEAVING EACH YEAR WHO REPORTED STUDIES OF USE IN THEIR EMPLOYMENTS

Those leaving in 1950	74%
Those leaving in 1949	74
Those leaving in 1948	78
Those leaving in 1947	83
Those leaving in 1943	71
Those leaving in 1942	83
Those leaving in 1941	82
Those leaving in 1932	81
Those leaving in 1931	100

At first sight it may appear that the percentage of former students who profit from studies in their employments is decreasing from year to year. However, 100 per cent in 1931 may easily be some kind of "wild point," and there appears to be no significant trend since then.

Only those years were tabulated during which more than ten students have left the University.

So much for the value of college study to former students in their jobs.

Humanistic-Social Value of Studies

To prepare students for employment is an important, but by no means the only objective of engineering instruction. The undergraduate engineering student should acquire much besides specific technical competences and skills. He should obtain what we call a "humanistic-social" education to round him out as a man and a citizen.

President Harvey Davis, Dean A. A. Potter, and doubtless others, have gone so far as to insist to us again and again that an undergraduate engineering education is altogether appropriate, in this machine and industrial age, even for the young American who has no intention whatever of becoming an engineer.

We proposed a number of questions in order to ascertain if and how their college studies have been useful in the humanistic-social growth and development of our former students. These questions follow, together with report data from the former students in answer to the questions, and our own remarks.

HAVE THEIR COLLEGE STUDIES BEEN OF USE TO THE FORMER STUDENTS IN THEIR HUMANISTIC-SOCIAL DEVELOPMENT? (Table 10)

TABLE 10

ALL REPORTING FORMER STUDENTS. PERCENTAGE DISTRIBUTION BY OPINION CONCERNING HUMANISTIC-SOCIAL VALUE OF STUDIES

Studies of humanistic-social value	84%
Studies of no humanistic-social value	14.2
No answer	1.8

Most people who think about the matter at all are probably of the opinion

that to prepare for employment is the principal aim of engineering education, and that the humanistic-social aim is secondary. These former students seem to think differently. 84 per cent of them asserted that their college studies have been of humanistic-social value to them, while only 80 per cent (Table 3) found their studies of use in their employments.

IS THE HUMANISTIC-SOCIAL VALUE OF COLLEGE STUDIES AFFECTED BY THE NUMBER OF YEARS OF THE CURRICULUM THE FORMER STUDENTS COMPLETED? (Table 11)

TABLE 11

ALL REPORTING FORMER STUDENTS BY YEARS OF THE CURRICULUM COMPLETED. PERCENTAGE COMPLETING EACH YEAR WHO REPORTED STUDIES OF HUMANISTIC-SOCIAL VALUE

Completed one year	78%
Completed two years	85
Completed three years	81
Completed four years (Five year curricula in University of Detroit)	95

The former students profited in their humanistic-social development approximately in proportion to the years they spent in the College of Engineering. This just about checks with the corresponding advantage of college studies in employment (Table 6).

JUST HOW HAVE COLLEGE STUDIES BEEN OF USE IN THE HUMANISTIC-SOCIAL DEVELOPMENT OF FORMER STUDENTS? (Table 12)

TABLE 12

FORMER STUDENTS WHOSE STUDIES HAVE BEEN VALUABLE IN HUMANISTIC-SOCIAL DEVELOPMENT. PERCENTAGE OF TOTAL REPORTING HOW STUDIES HAVE BEEN OF VALUE

Understanding of the viewpoints, habits and ways of living and acting of fellow men	65.7%
Ability in speaking and writing	63.7
Understanding of right and wrong	54.2
Understanding of the problems of living together, and of social, civil and government questions, etc.	48.4
Interest in and appreciation of literary and artistic productions	31.6
Advantages not listed	34.8

63.7 per cent of the former students declared that they had learned how to express themselves. This was especially gratifying to the faculty because we hear so many and such frequent complaints that engineers can neither speak nor write effectively.

HAVE THE FORMER STUDENTS BEEN HELD BACK IN THEIR HUMANISTIC-SOCIAL DEVELOPMENT BY LACK OF A DEGREE? (Table 13)

TABLE 13

ALL REPORTING FORMER STUDENTS. PERCENTAGE DISTRIBUTION ACCORDING TO HANDICAP IN HUMANISTIC-SOCIAL DEVELOPMENT BY LACK OF DEGREE

Held back by lack of degree	6.2%
Not held back by lack of degree	88.1
No answer	5.7

As we might expect, a degree seems to be more useful in employment than in humanistic-social development. 6.2 per cent found themselves retarded in humanistic-social development by lack of a degree, while 24.8 per cent found themselves retarded in employment (Table 8).

84 per cent of the former students reported their studies useful in humanistic-social development (Table 10), while only 6.2 per cent of them felt handicapped by lack of a degree. It follows that the difference of 77.8 per cent, or more than three quarters of the former students, highly prize the schooling they did have, but consider it of no consequence that they did not graduate. They might think otherwise, of course, if they had completed the curriculum.

Does not this information at least suggest a question: have we perhaps been underrating college environment and contacts as a factor in education, as compared with the system of courses and exercises we call the curriculum?

HAVE THE PASSING OF YEARS AND CHANGING CONDITIONS HAD ANY EFFECT UPON THE VALUE OF COLLEGE STUDIES IN THE HUMANISTIC-SOCIAL DEVELOPMENT OF FORMER STUDENTS? (Table 14)

TABLE 14

ALL REPORTING FORMER STUDENTS BY CALENDAR YEARS IN WHICH THEY LEFT THE UNIVERSITY. PERCENTAGE LEAVING EACH YEAR WHO REPORTED STUDIES OF VALUE IN HUMANISTIC-SOCIAL DEVELOPMENT

Those leaving in 1950	78%
Those leaving in 1949	81
Those leaving in 1948	78
Those leaving in 1947	91
Those leaving in 1943	93
Those leaving in 1942	89
Those leaving in 1941	91
Those leaving in 1932	88
Those leaving in 1931	85

As in the case of the advantages of college studies in employment (Table 9), there appears to be no significant change from year to year.

And again, only those years have been tabulated in which more than ten of the former students have given up their studies.

Over-all Comment

We obviously could not reach every single former student in a survey of this kind, but we did want to be sure that we had a proper sample.

The 226 former students who sent in their reports are just about 2.26 per cent of nearly 10,000 who have quit the University's College of Engineering since 1930. They represent every year except two since 1930, every branch of engineering which is taught in the University and, as indicated, a variety of occupations ranging from the highly technical to the distinctly non-technical. These 226 presumably represent a cross section of former students as to economic status, mode of life, viewpoint and temperament. A large percentage of them are residents of Detroit or its environment, a distinctly industrial community. There, if anywhere, engineers can live the lives and have the experiences which are typical of their profession.

Of the former students we were able to reach, 26.9 per cent returned their reports. This is certainly excellent cooperation. In fact, such a percentage of returns from graduates might be altogether satisfactory. The graduate is ordinarily more devoted to alma mater; the man who finished only a year or two can hardly be expected to display extraordinary school loyalty.

We realize, of course, that the former students can do no more than express an opinion, and that their opinions are likely to be influenced by the mood or feeling of the moment. It is probably impossible quantitatively and objectively to measure the value of education to the individual.

We asked our former students not to sign their reports. We assume, though, that those former students who have been successful in their careers are more disposed to prepare a report of this kind than those who have not done so well. Hence, the data submitted to us may be rather more favorable than the average; and this in spite of the occasional but familiar type of critical and discontented person who seems to enjoy broadcasting his complaints.

We took all these considerations into account in formulating our conclusions.

Conclusions

We believe that the data warrant our concluding as follows:

a) A considerable percentage of non-graduating former students of our College of Engineering, probably a majority, derive benefits from completing a portion of the curriculum, both in their employments and in their humanistic-social development. The benefits are apparently sufficient to justify the time, efforts and funds which the students expend for their schooling.

b) Our faculty may well be in error when we advise withdrawing students to avoid jobs in engineering and in industry.

c) We might do well to consider reconstructing our curricula in such manner that the student shall have completed at the close of each successive year, if not of each successive semester, an integrated system of courses and studies, an ab-

breviated curriculum with limited objectives, so to speak, but a reasonably unified curriculum nevertheless.

d) We should very probably take measures to revise our traditions, policies, attitudes and procedures in order that we shall in no way reflect upon the student who is unable to graduate for one reason or another.

We propose these conclusions with some trepidation. We fear that we may incur the wrath of those—and we recognize their number and their importance—who are opposed to the doing or the saying of anything which might in any way weaken the determination of students to persevere to graduation.

We don't pretend that these are new ideas or proposals. In fact, for some years Purdue University has granted certificates to those students who leave the University without graduating. As described by Dr. F. C. Hockema, Vice President, the certificate is like a diploma in general appearance, it bears the signature of the Registrar and the seal of the University, and declares that the recipient "was enrolled as a student from . . . to . . . and successfully completed the courses listed herewith." On the back of the certificate is entered a schedule, in the manner of a transcript, of those courses which the student has successfully completed. Courses which he failed or did not complete, if any, are omitted. Officers of the University believe that the certificate should very much improve the standing in his community of the young man who did not or could not remain to earn a degree.

And as long ago as 1930, the Report of Investigation of Engineering Education suggested that

"much may be done to steady the student and to draw out his best efforts if, in the face of impending voluntary self-elimination, some nearer goal were visible. This goal might be set up in the form of certifications of the work done at the end of each stage and formal admissions to the next stage. Associateships in engineering might properly be issued at the completion of the first two years' work."[3]

While these ideas and proposals are not new, they appear to be materially strengthened and supported by the opinions of the 226 former students who participated in this project.

We undertook this investigation in order to discover how instruction, courses and curricula might better serve the non-graduating student. But we suspect that much of the information may be utilized, likewise, for improving our teaching of those students who do graduate.

All of you have been thinking about what happens to the non-graduating students who leave your institutions. We venture to hope that this statement of ours may arouse sufficient interest and curiosity that some of you may undertake similar investigations among your non-graduating former students. If any of you do, we shall be very grateful if you will let us see the results you obtain.

NOTE: Report forms returned by former students contain a variety of information. Readers may inquire about combinations and relations of this information other than those which appear in the tables. For this purpose, the report forms will be preserved three months following the date of this publication.

[3] Society for the Promotion of Engineering Education, *op. cit.*, I, 213.

Engineering Education—A Bridge Between Ignorance and Understanding*

By F. M. DAWSON

President, ASEE, 1950–51; Dean of Engineering, State University of Iowa

The American Society for Engineering Education has always been extremely active in furthering the interests of Engineers in their profession. It has been wise and courageous also in stressing the educational side of its twofold duty of training and at the same time educating our clientele, the students. Primarily, we are a society of educators with a special job of developing, as best we may, embryo engineers. Young men and women come to our schools and colleges directly from high school at about the age of seventeen. We would like to do more for them than we usually are able to do as teaching is limited to 144 to 156 weeks in the average four year course. Before going any further, let me point out that 144 weeks is not a long time and that all must make the utmost use of their talents if the job is to be accomplished in such a short time. Several colleges have found it necessary to extend the time of formal training to five academic years, others to four and one-half or four years and summer sessions or camps. Those operating on the cooperative plan of Engineering Education are likewise limited in time. But in any case, we as Engineering teachers had some 184,000 students of all types under our charge last year. In almost all cases, these students ranked in the upper one-half of their high school class and because of student mortality, caused by the usual consequence of adjustment to college life and to the rigorous training of an engineer, we know that less than one-half of those who began as freshmen will be graduated. All of which means that we had a selected group to start with and an even more select group at the finish of the formal courses for the various degrees.

Concerning these students, the question is always before us, "What are we trying to do and how well are we doing it?" An answer to at least part of this question will be given you later this morning in the report of our distinguished committee on the Improvement of Teaching, which has been sparked by Dr. L. E. Grinter. This is one of the major, and to me the most significant accomplishment of the Society for the year 1950–1951.

An excellent source of information concerning our problem and its answers came to me unexpectedly. Recently, I reviewed the presidential address printed in the proceedings of the ASEE and its predecessor the SPEE. If my memory had been really good I should not have been, but I *was* amazed at the excellence of these addresses. If anyone wishes to do a good turn for himself and for the Society, nothing could be better or more helpful to the teaching profession than making a compilation of these talks. The full text of some fifty-five speeches would be too long for a book, but if edited, I am sure they would form a firm foundation, particularly for beginning teachers.

* Presidential Address, Annual Meeting of the ASEE, East Lansing, Michigan, June 27, 1951.

Bridging the Gulf

In this review one prominent feature stood out above all others and it is to this that I wish to devote my remarks this morning. Many have treated engineering education as an end in itself, giving the impression that if only we were well-trained or sufficiently indoctrinated or thoroughly educated all else would follow as a matter of course. To me this is not so. I believe that education, particularly engineering education, is a method or way and not an end in itself. It is a means whereby something else may be accomplished.

Education may be likened unto a bridge spanning the gulf between ignorance and understanding. It is a way, a means of transport. It is true that in and of itself it is a material structure, but its main purpose is to be a support for a highway or a railway, in other words, a means of conveyance.

Imagine a canyon deep and wide. On one side is ignorance, dark and dismal and full of superstitions and fears. On the other side of the canyon is understanding, which includes knowledge, freedom to think and an absence of these terrible restraints on thoughts, such as the fear of ridicule, the fear of fear itself. Understanding gives a chance for the brilliant light of opportunity to show the way to better living, better mental health and freedom of religion guaranteed to all.

It is possible for a man to cross the chasm by climbing down one side, going across the treacherous rocks at the bottom and laboriously climbing up the other side. This is the way it was done of old each had to find his on way down, across and up again. Then someone threw a rope across and we had a rope bridge on which a few only could cross at a time. These few had to be hardy souls who braved the flimsy swaying span. Later, stronger and better bridges were built and they served their purpose of furnishing a way or method of progressing from ignorance to understanding. Many could now cross whereas before only individuals could go.

My main thesis, therefore, is that education is something that is a means rather than an end. In this respect it is something like money. It is valuable when properly used and dangerous when misused. It is necessary and desirable, not for itself, but the use to which it may be put. Money, at least present day money, is a medium of exchange enabling the possessor to transfer from one to another certain rights to things. Now education is to be desired, not for itself, but for the use to which it may be put. It is a medium of exchange giving to its possessor the ability to have for himself and others the wisdom of the past and a knowledge of science with its many applications. Unlike money, however, once possessed, it cannot be stolen or devaluated, but it may be misapplied just as money may be foolishly wasted.

True engineering education must look beyond the problem of teaching subject matter. This is partly because most students must be shown the way from one side of the canyon to the other. Mathematical formulas and the physical laws of the universe are not enough. The intangibles of education, such as personal characteristics, must be included. It is our job to do what we can to go beyond the usual and inculcate those features so ably described by the late President Wickenden in his article entitled "The Second Mile." For those who are not familiar with this article, I recommend it to you.

A recent article in the *New York Times* (Margaret B. Pickel, June 3rd, 1951) has the somewhat startling headline "Education is the Teacher's Job" with the subtitle "The trouble is there are so many 'experts' trying to share it, that they ignore the true expert in the field, the educator." For many years we have been asking men from industry, from business, from almost every walk of life what should we do to save our youth from all types of trouble, most of it imaginary. As a result, I agree with the article in the

Times, "and surely it must shake the layman's confidence in education to be constantly asked for advice about it. Imagine the waiting room of a doctor on the look-out for surgical suggestions, yet teachers are increasingly taking counsel from outsiders. They ask a panel of business men what they think is the most important part of an education and the business men decide that it is good personal attitudes and work habits, enthusiasm for work, neatness, good manners, tact and punctuality, listing these traits ahead of the basic skills." Have we forgotten that the traits listed are the by-products of a disciplined education and that every teacher worth his pay must consider these in his work. If he does not, then he should leave teaching because the inculcating of these qualities should be the main purpose of our profession. I believe that by diligent work this can be accomplished without sacrificing any content. If some of the "talk-type of training" which requires little thought and less preparation were omitted we would have plenty of time for real training. But it would be hard work for the teacher and frequently harder still to defend it from the purely utilitarian and repetitious get-it-quick methods long advocated by some men who ought to know better.

Lest you think that I am advocating that we as teachers should not pay attention to what our friends in industry and business say, let me enlarge a little by paying personal tribute to the several excellent surveys made by committees of this Society, as well as those made by other organizations, using properly phrased questionnaires and studies of opinion. These are necessary and have proved their value. But they must be well conceived, thoroughly organized and followed up or the results may be worse than if they had not been undertaken. Following the consensus of a good survey is something quite different from being swayed by the opinions of every man who happens to be a loud-talker, without the inhibitions of real knowledge of the subject, and who delights in character assassination by innuendo. For example, I know of one school where a fundamental course of study was altered to suit the whims of a local manufacturer of candy.

Development of Excellence

Think again of education as a way or a bridge across a wide and deep valley, a means whereby something of value is reached leaving ignorance behind. Does this simile mean anything to you? Is the way clear and bright? Every bridge has structural members, each a part of the bridge itself and each necessary for its structural unity. As an example of the unity required, I wish to quote from President V. M. Hancher of the State University of Iowa in his charge to the candidates at commencement two weeks ago.

"Education has many tasks and many ends, one is that education in mid-Twentieth Century America should be the development of excellence among all our people."

"The development of excellence implies respect for the best. The development of democracy implies respect for the majority. How can education in mid-Twentieth Century America recognize two masters? Upon what principle or principles can we reconcile the superiority of excellence on the one hand with the consent of the majority on the other?"

"Now the tasks or functions of educational institutions are appropriate tasks in a democratic society attempting to establish economic independence and achieve social unity and cohesion. But, by stressing conformity, by substituting the judgment of the crowd for the judgment of the individual mind and conscience, they tend constantly toward mediocrity."

"Conformity is understandable, it is comfortable, it is easy. Usually it represents the average. There is nothing about it that stands out from the crowd. It possesses no sharp edges. It does not invite strange new thoughts, strange new

modes of conduct, or strange new patterns of life for the individual. It does not welcome eccentricity. It admires gregariousness, the current cliche, the predictable reaction."

"Democracy, based as it is on respect for human personality and dedicated to the preservation and sanctity of the individual, can easily degenerate into sentimental equalitariansm. This is equality run riot. Starting with the principle that all men are created free and equal in the sight of God and before the law, we end with the foolish notion that all men are identical in their gifts and powers. We begin with the dignity of the individual and we end with *the theory of the interchangeable man.* We end with the theory that men, resembling parts of an automobile or of a television set, are equally useful and competent in all the positions in society in which they may be placed, just as inanimate metallic bearings may be shifted from one machine to another without loss or efficiency or precision."

"But men are not machines and there is no such thing as the interchangeable man. In our more reflective moments we all recognize that the two most striking characteristics of human beings are the vast range of their similarities on the one hand and the vast range of their differences on the other."

"The fundamental problem of a democratic society is the reconcilation of respect for personality on the one hand with respect for excellence on the other, the reconcilation of the rule of the majority with tolerance for individual departures from the majority, the reconciliation of the will and the beliefs of the many with the excellence of the few. Democracy must be on guard against the prestige of the composite man—the apotheosis of the average—the man whose beliefs and ideas are a composite of all the beliefs and ideas that he has ever heard, without form or logic and without arrangement or consistency. For a hundred and seventy-five years, we have possessed so many blessings that we have scarcely needed to stress the importance of excellence. But now we stand in a new day. Those who oppose our way of life, and their satellite nations, outnumber us many times. On a man power basis, we face inevitable defeat in any armed conflict. Our hope lies not in numbers but in excellence. Therefore, the quality of excellence must be our first concern."

"It carries with it a fundamental honesty. When we have inculcated in the members of our society the goal of excellence, we shall have achieved an essential integrity which will make every man his own unkindest critic."

"These are the attributes of excellence —clarity of perception, persistence, self-reliance, ease and grace—the attributes of that excellence which we need so much in these difficult times. How are we to reconcile the attainment of excellence with respect for the average? Is there any ground upon which the two can meet? Must excellence be ever scornful of mediocrity? Must mediocrity always be suspicious of excellence? How can these two—the insights of the superior and the consent of the majority—be reconciled to provide us with a richer and better society?"

"The reconciliation seems to call for a twofold interpretation of democracy. On the one hand democracy must inculcate in every member of society that quality of excellence which requires him to work at the highest level of his capacity. On the other hand, democracy must inculcate respect for every member of society who, driven by the desire for excellence, works at the highest level of his capacity. In such a society every member would be useful and every member would be respected. Such a society would be truly democratic. Such a society is needed at this mid-Twentieth Century."

"It was truly said by Bernard of Chartres that 'we are dwarfs standing on the shoulders of giants.' We humans, alone in the animal world, possess history, a kind of cumulative memory, whereby we are able to build on the foundations

which others have laid before us. By this device we are able to have at our command all the inventions of ages past. Through this device we have universities and colleges, hospitals and schools, vast foundations and corporations, the principles of representative and of Federal government and the great concepts of Justice, Freedom, Liberty and Dignity of Man, which are basic to our civilization."

I have quoted at length from the address of Dr. Hancher because it fitted perfectly into what I had already written before he gave his charge to the candidates. Now to return to my own wording.

Intelligence and Character

Many have labored on the bridge and as a result many things have come to us because of the excellence of the past. They are our heritage. They come to us without cost and without price. Our forefathers paid for this inheritance. But this places us under a greater obligation —an obligation that we in turn will make excellence our goal, in order that the rich heritage of the past may be made even richer for the future. The only way in which we can pay our debt to those who preceded us is by making a better bridge for those who falter by the wayside.

If the foundation of our bridge of education is character what about the other parts of the structure which are equally necessary to carry the load of all who wish to cross from ignorance to understanding? I would first put intelligence as the main member, reliability is another and so we could go through the list of desirable attributes of the educated man such as tolerance and justice and knowledge of the world and of the individual, which must be contrasted with the treatment of man as a unit of the state and no value except as he conforms to the wishes of the state.

In conclusion, let me point out that the bridge permits going both forward and backward. We must be ever on the alert to see which way our students are likely to go. Mere mental exercise is not enough; just as a man walking back and forth on the bridge will not get him to the other side, so intellectual dilettantism will not produce results.

Our way, our method, our medium for progress requires a strong structure to stand the strains of the multitude who wish to cross, affected as they will be by the winds of adversity and the frosts of an inhospitable world; a bridge on a firm foundation, constructed with good materials, all welded together by science and technology, tempered with human kindness and love will enable us as teachers to be of value to our students. That is what is expected of us as men and women dedicated to a most challenging profession, namely that of being teachers of Engineering. Education is a way, a method of achieving certain desirable goals. May the whole structure show excellent craftmanship. May our Society be ever alive to its responsibilities.

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Lustre or Glitter?*

By JOHN A. HANNAH
President, Michigan State College

It is heartening to a college administrator to realize that such a Society as this exists and has a history of robust action. Engineers are generally considered to have extraordinary pride of profession. That they should have pride in the teaching of engineering sets them somewhat apart from some other groups I could name. They are distinctive, too, in that they are keenly interested in the commercial practice of their profession, and wide awake to all the governmental and social changes affecting engineers and engineering. You are to be congratulated upon your alertness and serious purpose; I sincerely hope you never lose your enthusiasm, for that enthusiasm is in a large measure responsible for the steady advancement American engineering has made in the comparatively brief period of its existence as a recognized profession, and for the high standards of engineering education in the United States.

It may not be news to many of you that Michigan State College was the forerunner of the land-grant colleges and universities of America with which so many of you are associated. Nearly a century ago there was established here on this campus the first college in the world in which agricultural subjects were taught for college credit. The old Michigan Agricultural College was the result of years of agitation on the part of those who were not content that higher education should be reserved for the sons of the rich and well-born, and who insisted that the promised benefits of scientific discoveries should be available for the solution of the troublesome problems of agriculture on the frontier.

Fore-runner of the Morrill Act

This pioneer college, having a revolutionary philosophy that the problems of living people were fit subjects for study by the best minds in a university, was established in 1855, ninety-six years ago. Within seven years, this revolutionary notion had made such headway that Congress passed the historic Morrill Act, creating the unique system of higher education known as the land-grant college system.

It is to the credit of those who were concerned with the industrial development of the United States that when President Lincoln signed the Morrill Act, it contained the mandatory provision that in addition to agriculture, the mechanic arts (what we now call engineering) should be taught in the new land-grand colleges, along with military tactics and subjects deemed desirable for the liberal and practical education of the industrial classes in the several pursuits and professions of life.

The passage of the Morrill Act creating the land-grant college system was one of the major contributions of America to the development of higher education. The freeing of higher education from its traditional bonds of the classical curricula, the reversal of educational interest from the dead past to things of the present and future, and the opening of the door of educational opportunity at the highest level to the sons

* Presented at the General Session of the ASEE at the 59th Annual Meeting, East Lansing, Michigan, June 27, 1951.

and daughters of all of the people instead of only the families of the rich or well-to-do are responsible to a great degree for the tremendous material progress this nation has made in the last 80 years.

I doubt that Senator Morrill, or even wise Abraham Lincoln, properly evaluated the creative forces they were unleashing. They were highly optimistic, of course, but it is to be doubted that even they could have understood how greatly they had wrought in placing the tools of creation and production in the hands of the common people, and training them in their use. They made possible the multiplication of native skills and aptitudes a thousand times, and made possible those miracles of agricultural and industrial production with which we amaze and dumbfound the rest of the world as a matter of routine.

Frankenstein Attributes of the Machine Age

Even in that era, many were impressed by the possibilities of the machine, and considered that they had come far along the road to the ultimate in discovery. For example, we find Emerson saying:

"Armed with his machinery man can dive, can fly, can see atoms like a gnat; he can peer into Uranus with his telescope, or knock down cities with his fists of gunpowder."

How astounded he would be if he could see the machines man has since built to do his bidding—and possibly, to accomplish his own destruction.

But perhaps Emerson would not be too astonished, after all, for he said this, too: "Things are in the saddle and ride mankind." Perhaps he would not be surprised to find mankind cowering in fear before the threat of the greatest machines of all, the products of rare inventive genius and great productive skill, perverted to an unholy purpose—the mass suicide of mankind.

The metaphor of Frankenstein's monster has been overworked in discussions of the plight of mankind in the Age of the Machine, but it has validity in emphasizing that man is in danger of destruction beneath the wheels or in the disintegrating flash of his own creations.

The error in our thinking is in attributing to the Machine all the attributes of human beings or of God himself—the ability to choose between good and evil, to create, to destroy, to accomplish miracles. We have failed to understand that in and of themselves, machines are utterly without value. By themselves, they can accomplish absolutely nothing. They are still subject to the will of man, and reflect in their accomplishments only the good or evil purposes of the men who operate them.

A great many people in our country have failed to understand this important point, and as a result too many Americans have been and still are members of the Cult of the Machine, and worshipers at its altar. Planes in flight, television, radio communication, streamlined trains, electronic permanent wave contrivances, electric scoreboards, motion picture films in technicolor—all these things have excited our admiration, and in too many cases, our idolatry. Those wonderful, shining gadgets of ours were the envy of the world though the roaring twenties, even through the great depression of the thirties, and most of all in World War II. Machines can do anything, we said to ourselves, and tried to glamorize our idols by streamlining them and painting them in bright and beautiful colors.

The Machine has had to share a place with the dollar above the altar of the materialistic among us. The Machine, of course, is the top-ranking god, for the dollar is in a very real sense the product of the Machine. But we have placed much faith in the dollar to perform tasks for us—indeed, sometimes it seems that we believe that anything can be bought with money, even peace and the love and admiration of all mankind.

But in recent years, as international tensions have persisted after the war that was to be the last great war, and as we

go on building more magnificant machines to preserve a precarious margin of safety in a world seemingly bent on war, we Americans are beginning to wonder whether our faith in the Machine and in the Dollar has not been misplaced.

Are we on the Right Track?

We have achieved the world's highest standard of living; we have put together the world's most stupendous industrial system; we have only six per cent of the world's population, and only seven per cent of its area, but we account for roughly half of its industrial output. We have loaned and given away billions of dollars in cash and credit and foodstuffs and industrial machinery. We have given away still more billions in the form of machines of war.

We have done all this, partly out of native generosity and partly out of self-interest, and what do we have to show for it? We have earned the bitter enmity of a good share of the world, an uneasy alliance with a smaller portion, and a close alliance with a very small portion. But we have not bought, with all of our dollars and all of our machines, the peace and security which we Americans cherish as our greatest ambition.

It is no wonder that we are beginning to question whether we are on the right track and beginning to ask whether we dare place our faith in machines, and in dollars, alone. That gnawing wonder is to blame for a great deal of the insecurity that all Americans feel these days when we see our taxes mounting, the cost of living mounting, the piles of war supplies mounting, and no peak in sight for any of them.

It is axiomatic that he who claims the credit for a particular plan or process is liable for the blame if the plan fails or the process goes awry. The unthinking folk who loudly sang the praises of the scientists for making all our wonderful gadgets possible are quick to say the same scientists are to blame when they find that those gadgets are not all they had expected them to be. As engineers, you have had your share of the blame from those whose thinking runs like this: If the atom bomb had not been invented by men like you, we would not be in this trouble today; if you had not developed all these wonderful mechanical devices, we would not be working ourselves to death trying to keep up with this mechanical world.

The fallacy of such thinking is obvious: the inventors and scientists and manufacturers and engineers are no more to blame for the miseries of the world than they were entitled to all of the credit when everything was going well.

Neither are the machines themselves to blame—the atom bomb is of no more importance than a grain of sand without man to direct its flight to the target and to time its detonation. It makes no difference at all to a mass of fissionable material whether its latent power is to be used for the generation of industrial power or the destruction of an indutrial city. The decisions lie in man, the thinking animal, not in the inanimate machines to which we have falsely ascribed so many human attributes. To paraphrase the famous words of Shakespeare: "The fault is not in our machines, but in ourselves—all of us."

This national malady of insecurity, and its causes, have great importance for those engaged in educational pursuits, perhaps more than for any other group, for we have been largely responsible for the condition. We have had as our task the training of the leaders of this country; it is we who have encouraged them in a materialistic view of life; it is we who have countenanced the stripping from the scientific curricula of the cultural subjects, and graduated engineers, who, we were proud to say, knew engineering and little else, biologists who knew biology and little else, chemists who knew chemistry and little else. Is it any wonder that these poor deluded students have not known what to do with their technical knowledge?

Who is to blame if they have not been trained to estimate the likely conse-

quences of their actions, and to judge their actions from the standpoint of social responsibility? How many educators have cried out in protest against a system that rewarded industrial genius with great material gains, and paid a comparatively small pittance to the musical genius or the great philosopher?

Is There Hope?

If our national feeling of insecurity is indeed attributable to a slackening national faith in material things, then I see great hope for America. Perhaps the American people will come in time to respect and honor—and reward—those who produce thoughts and ideas as well as those who produce things. In these times, when we find that our material advantages have not brought us peace and security, perhaps we will come to agree with Emerson that "a rush of thoughts is the only conceivable prosperity that can come to us."

What I am advocating here for education is a revamping and revision of curricula in many fields of study to make room for some of the courses directed to training students' minds and to refreshing their inner spirits, so as to make of them whole men and women instead of technical instruments prepared to carry out their mechanical functions in making adequate livings, but failures at making lives for themselves and others with whom they come in contact.

George Boas, the eminent professor of philosophy at the Johns Hopkins University, pleaded a strong case for the humanities and the social sciences recently at a symposium on Higher Education and Long-Range National Security. He made the telling point that "when all is said and done, it is the philosophy and poetry and architecture and sculpture (of the cultures of the past) which have survived as dynamic forces."

He went on to decry the current attitude towards students in his own and related fields, and made this comment:

"We are in a national situation where millions are being spent daily on studies the results of which will be weapons. The more deadly the weapons the better. Pure science is tolerated because it is suspected that it may contain implications useful for warfare. Psychology and economics are tolerated because it is hoped that the former may teach us how to beguile the enemy successfully into treason or cowardice, the latter because it may teach us how to capture or destroy the materials vital to the enemy's defense. But the historian, the student of language and literature, and especially that human gadfly, the philosopher, are not encouraged. They are not essential to defense. They are merely essential to civilization."

With due allowance for his natural prejudice, I believe we can agree that he has pointed to a fundamental weakness in our national character—our preoccupation with facts and figures to the exclusion of the human factors that play the major roles in determining human conduct and human history.

Glitter and Intrinsic Value

I do not mean to advocate the liberal arts curriculum for everyone, or for education obtained by reading 100 great books. One must be alive to enjoy life, and most of us have to earn a living to stay alive.

But on the other hand, students coming under our guidance and control must be taught some things beyond mere technical competence in their professions. Specifically, it is not enough to teach engineering students engineering and related subjects and little else. They should not leave our colleges and universities with the mistaken notion that everything in life can be reduced to a mathematical formula, and their relations with their fellow men determined by slide-rule calculations.

It does not matter how the broadening of study courses is accomplished. Here at Michigan State College, we maintain our Basic College, in which all of our freshmen and sophomores are required to take a number of common core courses

in which they are introduced to materials in all the great fields of knowledge. The purpose is to guarantee that we will no longer graduate music majors who know nothing of the physical and biological sciences, engineers who know little or nothing of history or art or the biological world in which they live, chemists who know nothing of the sciences in bordering fields or of the social sciences. And they all are required to demonstrate a reasonable proficiency in written and spoken English before they can earn a degree from this College.

But while we are broadening our courses to produce graduates who can honestly claim to be educated, we must narrow them too, in order that they may focus on some of the fundamental truths of which we have lost clear sight in recent generations. The glitter of modern civilization has obscured too much of the intrinsic value of such old-fashioned things as respect for the rights of others, respect for the persons of others, respect for the property of others, and respect for the opinions of others. Teachers of whatever subjects would be serving well if they laid some stress on those fundamental principles of conduct for the benefit of their students.

But most of all, I am sure you will agree, we must teach students to *think*. And they must learn to think, not only about problems in their own spheres of activity but about a great many other things as well. It seems evident that we cannot leave great decisions on matters of national and world policy to a small group elected or appointed to perform those specific functions. I believe that the decisions of the great mass of Americans will potentially be much sounder than those of any politicians ever elected to any offices. But they cannot be sound decisions unless they are based on comprehensive information and rational thinking. Colleges and Universities fail in their greatest mission if they are not truly centers for the encouragement and stimulation of thinking on the part of students and the general public as well.

Those who question whether the designer, the builder, and the operators of our machines should assume any social responsibility for the results of their actions might look with profit at the example set by such distinguished scientists as Compton, Einstein, DuBridge, and Bronk.

These men, who know better than any others the awful potentialities of atomic power, fully recognize the probable consequences of their creative action, and are laboring mightily to develop a social-political climate favorable to effective control of atomic energy for the benefit of mankind. Their concern does them great credit; their endeavor to minimize the destructive effects of their discoveries is a tremendously hopeful development. And if men such as these are prepared to assume some responsibility for their actions, then it is highly appropriate that others do likewise.

The Balance Between Specialization and Liberalization

Interested as we are in the present and the future, there is always something to be learned from the pioneers of the past. It is humbling to find that those who laid the foundations for our great industrial and economic development here in the United States saw far more clearly than we of recent generations the dangers of undiluted science and narrow specialization in education.

It is particularly appropriate here on this campus to recall the words of Bela Hubbard, one of the Michigan farmers who helped bring into being this first agricultural college, the forerunner of the land-grant college system. On one occasion, Hubbard described what he considered to be the ideal curriculum for the college he had in mind, and the emphasis was placed on the natural and physical sciences. But then he added a note of warning in which we now recognize wisdom and far-seeing vision. This is what he said:

"Nor should the claims of literature and the fine arts be wholly neglected, as tending to polish the mind and manner, and add greater lustre and dignity to life."

Remember, he was talking about education for the sons of farmers and workers here on what was then the frontier—and he was advocating that they study literature and fine arts. He was mightily interested in their receiving the scientific training they required to cope with the technical difficulties of farming, but he wanted their lives to have lustre and dignity, too. He might have been speaking as well for the engineers, the veterinarians, the home economists, the business administrators, and all the others who were to be trained here in the century to come. He might have been speaking for all the young men and women to be trained for the "several pursuits and professions of life," as the Morrill Act stated it. Incidentally, it is well to note that the Morrill Act provided for the "liberal and practical education" of the industrial classes of America, not the practical alone.

There is ample historical precedent for the idea that a college student shall have training narrow enough to equip him to make a living, and broad enough to equip him to make a life.

The young men and women we are sending into the world with diplomas in their hands will encounter some of the most perplexing questions ever to vex a generation. We will be doing less than justice to them if we do not give them the background of knowledge and the thinking knowhow they will require in the years ahead.

Determining just what that background and training should be is of course a task for individual teachers and individual colleges. But as a guide, we might remember that Milton more than three hundred years ago, in one of the best definitions of an education ever written, defined an educated man as one who can perform all the offices of peace and war with justice and magnanimity.

In the final analysis, an educated man in a democracy is one who is trained and conditioned to be an effective citizen. He need not necessarily be a man who has attained great wealth, or professional distinction, or high public office. He may not be known far beyond the borders of his own community.

But he will have been educated to contribute to the economic stability to the limits of his creative and productive skills; he will have been educated to contribute to the social stability by his understanding of the world around him and his tolerance for the rights and opinions of others; he will have been educated to contribute to the moral stability by his acceptance and observance of the fundamental values; and he will have been educated to contribute to the political stability by his reasoned, thinking approach to political issues, his rejection of demagogic appeals, and his willingness and ability to lead or to follow, with equal intelligence.

If we will keep such definitions of education in mind, we as educators will not think so much of graduating engineers, or chemists, or teachers, or home economists, or agriculturists, or accountants, as of graduating educated men and women, trained to be effective citizens of our democracy—men and women ready and willing to assume the duties of leadership in a nation crying for intelligent direction and guidance in a world full of confusion, insecurity, and doubt.

By so doing, we will contribute to the preservation and further advancement of the nation we all love, for men and women so trained will have confidence in America, her principles and her destiny, and confidence in America's ability to lead the world into an era of peace and understanding.

Lamme Award—1951—Allan R. Cullimore

To ALLAN REGINALD CULLIMORE, *engineer, soldier, teacher and engineering administrator, for his achievements as an engineer-citizen; his constructive statesmanship in engineering education; his devotion to the cause of young people in the Boy Scouts movement; and advocacy of citizenship training in engineering education; his consecration to the cause of young engineers as evidenced by his work in Engineers' Council for Professional Development, and his contributions to engineering practice as a member of this and other engineering societies, we award this the twenty-fourth Lamme Medal.*

ALLAN REGINALD CULLIMORE was born in Jacksonville, Illinois, on March 2, 1884, the older son of Dr. Thomas McIntyre Cullimore, a local physician and surgeon, and Mary Joy Cullimore—both parents being direct descendants of residents of Massachusetts Bay Colony. He attended the public schools of Jacksonville, where much of his boyhood was spent, and in 1903 enrolled in the Massachusetts Institute of Technology, after an early experience as Assistant in the United States Coast and Geodetic Survey along the Columbia River in Oregon had led him into the field of engineering.

In 1907 he graduated from M.I.T. with the degree of B.S. in C.E., and joined the instructing staff of the Institute as an Assistant in the Department of Civil Engineering. In 1909 he accepted a position as Superintendent of Construction in the City of St. Louis, and later was promoted to responsible charge of construction work on the erection of the new court house.

Dr. Cullimore's work in the field of engineering education began in 1912, as Dean of the College of Industrial Science of the University of Toledo. He founded that College, organizing and planning its courses, and for a time occupied the position of Acting President of the University

In 1916 Delaware College (now the University of Delaware) appointed him Dean of Engineering. His services at Delaware, however, were interrupted by the entrance of the United States into World War I. At the outset of the War, Dr. Cullimore was in charge of special courses for shipbuilders in the shipyards of Wilmington, Delaware, as well as specialized training for the U. S. Signal Corps in Wilmington. During this period he gave considerable time to the study of industrial accidents, particularly with the object of rehabilitation of workers crippled in industry. He made an extended tour through the United States and Canada, visiting hospitals and studying the work being done in the rehabilitation of wounded soldiers. On his return to Washington he was assigned by the Surgeon General of the U. S. Army to organize the program of rehabilitation on the Pacific Coast. Shortly afterward, he was commissioned a Major in the U. S. Army in Charge of the Division of Physical Reconstruction attached to the Office of the Surgeon General.

After the War he resumed his duties at Delaware College, also serving as General Consultant for the Federal Board for Vocational Education, which later became the Veterans Bureau.

In 1919 Dr. Cullimore left Delaware to undertake the development of engineering education in Newark, N. J. It has been at Newark, first as Director of Newark Technical School and Dean of the newly founded College of Engineering, and from 1927 to 1949 as President of the Newark College of Engineering, that Dr. Cullimore has pioneered, developed, and expanded the field of human relations in engineering education. It was through his efforts that the study of the humanities was introduced on an equal level with technical studies. He felt that only through this sense of social awareness could the successful engineer understand and work harmoniously with his fellow men.

Significant contributions which Dr. Cullimore has made have resulted from his firm conviction that those qualified young men and women who lacked financial means should have opportunities to obtain a sound engineering education. As a result of his unceasing efforts on their behalf, any high school graduate in the State of New Jersey who has the aptitude for and the interest in engineering need no longer be denied an engineering education because of lack of funds.

Synonymous with his efforts to equalize opportunity as well as to broaden the scope of engineering education, is Dr. Cullimore's interest in the proper guidance of youth. He served as Chairman of the Committee on Student Selection and Guidance of the E.C.P.D., and upon completion of this assignment, undertook the Chairmanship of the Subcommittee on Student Development of the Committee

on Engineering Schools, resulting in the publication of "The Most Desirable Personal Characteristics."

At the outbreak of World War II Dr. Cullimore was appointed Regional Adviser in Region No. 5 of the E.S.M.W.T. Program sponsored by the U. S. Office of Education. Concurrently with his work in the War Training Program, Dr. Cullimore served the N. J. Office of Civilian Defense as a member of the Technical Advisory Committee and as Director of the Newark Area, and was Regional Representative for the War Manpower Commission.

One of the principles which Dr. Cullimore has emphasized during his career at Newark is the engineer's responsibility as a citizen. In 1933 he was appointed Chairman of the Committee on the Engineer's Civic Responsibility of the A.S.M.E. In collaboration with the late Senator Roy V. Wright, he was responsible for the dissemination of this idea to students and young engineers, in the formation of a permanent lecture series at Newark College of Engineering.

Dr. Cullimore has been recognized as a leader in civic affairs in the Metropolitan Area of Northern New Jersey for thirty years. He has been active on numerous committees of the Chamber of Commerce of the City of Newark and of the State of New Jersey; has served on the Citizens' Advisory Committee to the Central Planning Board of Newark, and the Advisory Council of the Newark War Veterans' Service Bureau; and has been Chairman of the Essex County Council of the N. J. State Division Against Discrimination.

With his background in rehabilitation work, Dr. Cullimore serves as a Trustee of the Kessler Institute for Rehabilitation, one of the leading pioneer sanitoriums in this field. He has also acted as an advisory committeeman for the U. S. Department of Labor in its Study of the Utilization of Impaired Workers in Industry.

Over a period of years Dr. Cullimore has been active in the A.S.E.E. He was First Vice President in 1943–44; member of the Council 1940–43; has been Chairman of The Committee on the Orientation of Freshmen, Committee on Undergraduate Adjustment and Guidance, Committee on V-12 Examinations, and Committee on Conferences; and has served as a member of numerous other committees.

In line with his general enthusiasm for the welfare of young men and boys, Dr. Cullimore has shown a deep interest in the Boy Scouts of America. He was the recipient of the Silver Beaver Award for 1937 and the Silver Antelope Award for 1947, both for distinguished service to boyhood.

Dr. Cullimore holds the honorary degrees of D.Sc., University of Newark; D.Eng., Newark College of Engineering; D.End., Stevens Institute of Technology; and D.Eng., Rutgers University. He is First Honorary Member of the Professional Engineers' Society of Hudson County, New Jersey; member of Tau Beta Pi, Beta Theta Pi, Phi Kappa Phi, and Omicron Delta Kappa; member of the Newcomen Society, the Engineers' Club of New York, the Down Town Club of Newark, and Honorary Member of Newark Rotary.

He is the author of several publications, including: "Theory of the Slide Rule," 1913; "The Phillips & Mannheim Rule," 1923; "Selections for Engineering Students," 1929; "The Problem of Staff," 1933; "Anent Engineering and Culture," 1932; "Through Engineering Eyes," 1941. He has also contributed numerous articles to technical publications.

Since his retirement as President of Newark College of Engineering, Dr. Cullimore has been devoting a considerable part of his time to a project that had long been in his mind—the correlation of Industrial Relations and Personnel Relations work into an expanded Department of Management and Personnel at Newark College of Engineering, which he guides as Chairman.

In 1912 he married Edith Van Alst of Brooklyn. Their home is in South Orange, New Jersey.

George Westinghouse Award—1951—
Glenn Murphy

To GLENN MURPHY, *a master craftsman of the teaching art. Unsparing of himself, he develops in his students at each level of age and background the desire and ability to think; an eagerness to learn; a willingness to work. An exacting task master, a proflific writer, a skillful improvisor, an able supervisor of junior colleagues, he advances teaching along the broad front of precept, example and a genuine personal interest in each student with whom he has contact.*

GLENN MURPHY, sixth recipient of the ASEE George Westinghouse Award, has demonstrated an almost unbelievable versatility in his teaching and related accomplishments. While his proven productivity and growth potential are truly outstanding, even more remarkable is the forward pace which continues without sign of letup. One has but to scan thoughtfully the titles of Dr. Murphy's writings to recognize the technical versatility of the man at both graduate and undergraduate levels.

Of him one colleague has written: "In summary my appraisal of Dr. Murphy is that he is a master of teaching; he can successfully lead the student into the pleasures of real learning. He is a master of his subject matter; his publications bear witness to this fact. He has never been content to rest on past accomplishments." In the words of a former student: "Dr. Murphy enriches his students by far more than the technical information which he so capably presents. It is in his development of logical minds with the ability and fortitude to tackle new problems which cannot be dealt with by formula, that he makes a truly great contribution to the engineering profession."

Born in Boulder, Colorado, January 17, 1908, Murphy took his B.S. in civil engineering at the University of Colorado (with special honors) in 1929, followed by the M.S., 1930 and the professional CE, 1937. After a two-year assistantship at Illinois in the midst of the stimulus created by such mentors as

Wilson, Huntington, Moore, Seely, Richart, Westergaard and Cross, Murphy, in 1932 with his second M.S. degree became the fifth member of the year-old T. & A. M. staff at Iowa State College. Continued study concurrent with his teaching netted in 1935 the Ph.D. At the age of 33 he became, in 1941, a professor. With his marriage in 1934 to Frances Pearce, he secured a brilliant cooperative helpmate whose name receives well-earned mention in the preface of virtually every one of his books.

In spite of the heavy output and wide range of subject matter, the textbooks carry, not only the stamp of quality and educational craftsmanship but at least two of them document areas heretofore without comparable textbook coverage. Titles include: Properties of Engineering Materials, Materials Testing (co-author), Mechanics of Fluids, Mechanics of Materials, Advanced Mechanics of Materials, and Similitude in Engineering. He was also co-author for one section of the O'Rourke "General Engineering Handbook." In addition to the books is authorship or co-authorship of three Iowa Engineering Experiment Station research bulletins and various papers and discussions published under such auspices as ASTM, ASEE, ASME and the Seventh International Congress for Applied Mechanics. A major editorial task is his position as Editor, Mechanics Series for Ronald Press. He has also long been an abstractor for the *Journal of the American Concrete Institute* and currently abstracts for the *Applied Mechanics Review*.

As Senior Engineer in the Institute for Atomic Research (half time) since 1949, Dr. Murphy is in charge of the Nuclear Engineering group in the Ames Laboratory of the Atomic Energy Commission. He is a registered professional engineer in the state of Iowa.

Of professional affiliations the list is long but representative of actual interests and in most cases participation. A member of ASEE since graduation in 1929, Dr. Murphy is a former member of the Council, a past chairman of the Mechanics Division and at present Editor of the *Bulletin of the Mechanics Division*, launched in 1950 during his chairmanship. The 1950 ASEE Summer School for Teachers of Engineering Mechanics (the first since 1929) was his conception and with the aid of loyal colleagues it proved to be a highly successful undertaking and the largest mechanics summer school yet held.

Other technical affiliations include ASCE, ASME, Amer. Conc. Inst., Soc. Exper. Stress Analysis, Iowa Engr'g Soc., Inst. of Aeronautical Sciences and Inst. Argentina de Racionalización de Materiales in addition to the honor societies of Tau Beta Pi, Chi Epsilon, Phi Kappa Phi and Sigma Xi (President of the local chapter 1949–50).

ANNUAL MEETING

June 23–27, 1952

Dartmouth College **Hanover, N.H.**

The Nature of Good Teaching*

By R. L. SWEIGERT

Dean of Graduate Division, Georgia Institute of Technology

The improvement of teaching at the college level involves many things. Some of these are concerned with what goes on in the classroom and some are concerned with matters that indirectly affect what goes on in the classroom.

Trained teachers are needed now for most all fields of human action. In former years the college degree in some miraculous manner was supposed to qualify one for teaching. However, it is now evident that knowledge of subject matter alone does not provide complete qualifications.

The following items are a condensation from an article on the improvement of college teaching by Dr. C. C. Crawford of the University of Southern California. They indicate that there are many components to the job of good teaching and are listed for that reason.

1. The starting of a career in college teaching.
2. How to win and hold the good-will of students.
3. How to operate classroom routine.
4. How to keep student interest at a high level.
5. How to make your teaching practical, functional, or worthwhile.
6. How to plan and organize college courses.
7. How to prepare functional syllabuses and textbooks for college courses.
8. How to manage related library and textbook materials.
9. How to direct the exchange of ideas.
10. How to persuade, convince or influence college students.
11. How to speak effectively in the college classroom.
12. How to illustrate or demonstrate your ideas.
13. How to direct student practice or performance.
14. How to promote originality, research and invention.
15. How to improve the learning techniques of college students.
16. How to fit instruction to varied abilities and needs.
17. How to maintain proper levels of work and mastery.
18. How to teach many students at one time and manage large classes.
19. How to check up on student accomplishment.
20. How to help young people to plan and manage their lives.

Since this discussion is on the nature of good teaching the items mentioned above will not be expanded upon.

All higher education will be benefited when some group has the imagination and courage through comprehensive research and study to formulate criteria of good teaching, systematic procedures for appraising it, and the most effective steps for its improvement.

In any discussion of improving college teaching or of training college teachers it seems necessary that there be

* Presented at the Southeastern Section Meeting of the ASEE, Biloxi, Mississippi, March 22–24, 1951.

some statements made as to what constitutes good teaching; what is the nature of good teaching. Effective learning is the result that the good teacher is after, because, after all, if there is no learning there is no teaching. One definition of learning that seems very appropriate is: "Learning is a *change in performance* as a function of practice, the change having a direction that satisfies *current motivation* of the individual."

The change in performance that we are concerned with is the production of increased competence in the field being studied. This involves (a) producing an understanding of the fundamentals; (b) developing the ability to use the fundamentals in new situations. These become prime objectives in the educational process.

Learning and Motivation

To accomplish the two objectives, the manner in which we learn must be considered. Some basic concepts can be taken from educational psychology.

1. We learn by doing (mental or physical). The question can be raised: Does anyone really learn by passive acceptance? The answer of the psychologist seems to be largely in the negative.

I would like to give the following quotation: "There's one and only one way to receive an education, that is to get it for yourself. We hear much said about self-educated men, and a broad distinction is made between them and others; but the truth is, that every man who is educated at all, is, and must be, self-educated. There are no more two methods in which the mind can make progress than there are two methods in which plants can grow. One seed may be blown by the winds, and cast upon the southern, or perchance on the northern side of some distant hill, and there germinate and take root, and do battle along with the elements, and it may be so favored by the soil and climate that it shall lift itself in surpassing strength and beauty; another may be planted carefully in good soil, and the hand of tillage may be applied to it, yet must this also draw for itself nutriment from the soil, and for itself withstand the rush of the tempest, and lift its head only as it strikes its roots deep in the earth. *It is for the want of understanding this properly that extravagant expectations are entertained of instructors, and of institutions; and that those who go to college sometimes expect, and the community expect, that they will be learned of course, as if they could be inoculated with knowledge, or obtain it by absorption.* This broad distinction between self-educated man and others has done harm; for young men will not set themselves efficiently at work until they feel that there is an all important part which they must perform for themselves, and which no one can do for them." The above is from Mark Hopkins, 1836. It apears to me that this statement is as good today as the day that it was made. It is unfortunate that we have not given greater attention to such key concepts stated many years ago.

2. Consideration should be given to stimulus-response reactions. The time necessary for learning, the effect of plateaus of learning, and the matter of forgetting (the reverse of learning) all enter the educational process.

3. There must be consideration of the motivation limit, the matter of incentives. (A student goes no further than he desires.)

4. We need to give adequate and full consideration to how learning takes place.

   a. First we have motivation; the matter of rewards, punishment, competition, and satisfaction must receive attention.
   b. Next we are concerned with the conditioning of the student or with preparing him in such a way that he is in a state of readiness for learning, that his attitude is the best for learning.
   c. Then a task must be established. This means having definite objec-

tives and definite work to be done by the student.

d. We learn by doing, by practice. Therefore the problem of student action and repetition comes to the fore. Repetition means the use of time, and time is limited. Therefore we need to know at least roughly, the extent of repetition necessary to provide the necessary improvement in performance.

e. We receive through the various senses. Therefore we need to know how to use these various senses in the most effective way to get the results we are after. All things mentioned about the student involves student activities. It needs to be continually emphasized that all learning takes place through activity by the student.

We might list seven types of learning that would bear consideration in a first-class learning situation. While all seven are important, two of them involving the development of emotional activities and the development of attitudes and ideals will be passed over and five of direct relationship to learning in the sciences and engineering will be listed. These are:

1. The development of motor skills. (In the main this type of development would be minor in professional education except for experimentation.)
2. The development of perception—awareness of action.
3. Memorizing—association.
4. Development of understanding.
   a. Observation.
   b. Listening.
   c. Reading.
   d. Abstraction.
   e. Analyzing.
   f. Generalizing.
5. The development of problem solving.

Handicaps to Learning

There are certain handicaps to learning which bear careful attention, and which in many cases are given little consideration. These handicaps include:

1. Fatigue (both mental and physical).

   Factors affecting fatigue are:

   a. Number of classes in a row.
   b. Poor lighting.
   c. Poor desks.
   d. Poor tools.
   e. The pace too fast or monotonous.
   f. Poor teaching itself!

2. Distractions:

   a. Noise.
   b. Instructor mannerisms.
   c. Improperly used visual aids.

3. Poor ventilation.
4. Poor vision.
5. Poor acoustics.

Statistical studies made on the educational processes at three different institutions of higher education appear to give us some valuable information in regard to teaching from the viewpoint of the learner. Two of the studies involve undergraduates, one being made in a non-research type of institution, and the second being made in an institution that places considerable emphasis upon research. The study at the third institution was a study of graduates who had been out ten or more years. It was interesting to note that in the non-research institution the Associate Professors ranked at the bottom and in the research institution they ranked at the top of the list in the quality of their teaching. In the non-research institution, young instructors, the group with the least experience in teaching, ranked above both Assistant and Associate Professors. According to the students they possessed one characteristic at a much higher level than the older men, and that was enthusiasm. The faculty was rated lowest on its ability to stimulate students, while students gave a

very high rating to this characteristic as an element of good teaching.

Four Basis Elements

From the above basic concepts on learning and from the statistical studies made there have been determined what may be called four elements of good teaching. These four most important elements of good teaching stated in the order of importance as determined from statistical studies made with students and successful alumni are:

1. *Inspiration* (motivation). Every word and every action of the teacher encourages or discourages, creates a desire to learn or destroy the incentive to learn.

2. *Ability to explain*—coupled with patience, sympathy, and willingness to explain, it is a top asset.

3. *Knowledge of field.* An instructor's knowledge should be such that he does not have to concentrate upon the material but can concentrate upon the student.

4. *Organization.* Clear and concise statements of over-all and individual class objectives are essential. Various assignments should dovetail.

If an instructor knows his field, properly organizes his work, can and is ready to explain, and above all, can stimulate and motivate his students to a high level of activity, he is bound to get excellent results as demonstrated by the very nature of learning itself. Improved performance through developing understanding and ability to use fundamentals in new situations will result.

College Notes

A plan for a liberal education in engineering was announced by Dr. John R. Dunning, dean of the School of Engineering of **Columbia University.** Twelve selected liberal arts colleges have entered into an agreement with Columbia's School of Engineering to provide this unusual opportunity for educating professionally trained engineers. A student interested in the study of engineering will have the opportunity of studying three years at one of the cooperating liberal arts colleges and two years at Columbia. Upon the satisfactory completion of three years of study at one of the twelve liberal arts colleges, the student will be automatically admitted to Columbia's School of Engineering for two years of engineering study. Completion of the five year program will result in appropriate Bachelor's degrees from both Columbia and the liberal arts colleges.

The College and Schools of Engineering and Mines at the **University of Pittsburgh** have announced a new cooperative program enabling students to gain training in both liberal arts and engineering. The plan includes a total of five years work and leads to a bachelor of science degree and a bachelor of science degree in engineering. Students entering this course and completing three years of work in the College and two years of work in the School of Engineering or Mines may satisfy the requirements for the bachelor of science degree from The College at the end of the fourth year and a bachelor of science degree from the School of Engineering or of Mines at the end of the fifth year. This program, which a student may enter next Fall, will be similar to two degree programs in effect for students in other liberal arts colleges.

Graduate Study in Structural Engineering*

By A. A. BRIELMAIER

Professor of Civil Engineering, Washington University

Need for Graduate Study

At the present time when so much is heard about training the engineer in the humanities and developing his social consciousness, it is with some hesitation that one brings forward the question of specialized training in one of the many fields of engineering. The present complexity, however, of all fields of engineering and the rate at which they are being explored and expanded make obvious the need for highly trained engineers.

It is the purpose of this paper to discuss briefly the general pattern of graduate study, to present an outline for such study in structural engineering, to consider the conditions essential to good graduate work and to formulate the aims of graduate study in structural engineering. The paper deals with graduate study in the United States of today which leads to the Master of Science degree after one year of study beyond the Bachelor of Science degree, and to the doctorate, either Ph.D. or D.Sc., after three years of study beyond the B.Sc. The advisability or feasibility of requiring some studies in the liberal arts at a junior college or at the university prior to beginning engineering studies, will not be here considered. Neither will the advantages or disadvantages of the five-year engineering curriculum be taken up; although adopted by several universities it is still the exception.

The engineering graduate is expected to have some acquaintanceship with the liberal arts in addition to broad engineering knowledge and special competency in one of the major fields. Of course it is impossible to achieve this in four years. The young engineer, leaving the university with the degree of B.Sc., has a general knowledge of the world he lives in, a fair ability to use written and spoken English, some knowledge of the fundamentals of all engineering and some familiarity with the subdivisions of his field of engineering. These subdivisions have however themselves become complex and the young graduate often finds it difficult to function satisfactorily in them without more knowledge than he obtained in four years at engineering school. This additional knowledge is frequently gained through experience. In some subdivisions of civil engineering it is very difficult to become competent through experience alone, even though it be supplemented by private study, superimposed on four years of formal engineering education. Structural engineering is one of these subdivisions.

The young civil engineering graduate of more than average ability who is interested in making structural engineering his life-work, whether in design or research, should seriously consider taking graduate work, at least to the extent represented by the M.Sc. degree. If he does not have this special training he may find himself inadequate for the performance expected of him and he certainly will find competition difficult with men of equal or perhaps less native

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*Presented before the Civil Engineering Division at the 59th Annual Meeting of the ASEE, East Lansing, Michigan, June 25, 1951.

ability who have had the training. In order, however, that he may know more surely where his interests lie and also that his studies may be carried out with the advantage given by greater judgment and some practical knowledge, it is desirable that several years of experience be obtained before advanced studies are started. In choosing the school for his future studies, it would be well for him to consider institutions other than the one where he received the B.Sc. in order to have contact with new teachers and new viewpoints.

Program of Studies

The purpose of graduate work in structures is to impart a specialized knowledge to engineers who already have an understanding of engineering fundamentals and a familiarity with the various sub-divisions of civil engineering. The detailed aims of the graduate program may be considered from two aspects: the knowledge to be gained and the mental attitude to be developed.

The knowledge to be gained may be roughly itemized as follows:

a) *mechanics:* usual assumptions, their validity and limitations; problems outside these limitations; elasticity and elastic stability.
b) *behavior of materials* (including soils) and structures: critical study based on experimental data.
c) *structural analysis:* frames consisting of members subjected to axial, flexural or torsional loading or to combination of these loadings.
d) *structural design:* members and framing of more than ordinary difficulty.
e) *thesis:* an independent but somewhat guided treatment of a problem in structural engineering or in mechanics, preferably one whose nature or solution is of timely interest.

The thesis for the M.Sc. degree is considered of great importance. Although it is impossible to delineate exactly the characteristics of an acceptable thesis, some general requirements may be mentioned. It is not expected that the thesis will be of such startling nature as to create excitement in engineering circles, but it is expected that the work would be of interest to many structural engineers. The application of well-known methods of analysis and design to a routine problem is not sufficient. The subject must be one of some difficulty, requiring a knowledge of the fundamental theory involved and calling for some originality in the solution. It must also be one whose treatment is not already well known and available. It is desirable that it be a problem of interest in the field in which it occurs. The effect desired on mental attitude is the promotion of independent thought, self-reliance and the courage to attack now problems. The thesis may have its greatest value when viewed in this light.

The subject matter just described might be presented in the following courses, each of which bears three credits, on the basis of twelve credits representing a semester's work and twenty-four credits being the minimum requirement for the M.Sc. degree:

Advanced Strength of Materials or Theory of Elasticity
Elastic Stability
Steel Design
Concrete Design
Soil Mechanics
Structural Analysis: Continuous Frames
Structural Analysis: Indeterminate Trusses
Thesis

The graduate program for the M.Sc. degree, based on the foregoing outline with perhaps one or two courses not directly related to the topics itemized, would require two very crowded semesters. Three semesters would be preferable since they would permit a slower pace with more time for reading and in-

dependent thought. The graduate program should never become merely a non-integrated collection of miscellaneous courses, whose chief purpose, although perhaps not recognized, is to keep the student occupied while he spends another year at school.

The two further years required for the doctorate may well be considered as an extension of the study for the M.Sc. degree, but with less rigidly prescribed course requirements. It is desirable that the M.Sc. degree be obtained in view of the experience gained in preparation of the thesis. The second year should be devoted to independent study of special topics in structural engineering and in mechanics, and to some formal courses, especially in mathematics. The nature of the courses would depend upon the direction of the student's interest. Along with these special topics and formal courses should go a developing familiarity with, and interest in, the literature and history of the fields of structural engineering and mechanics. After the second year is terminated with the comprehensive written and oral examinations, the third year is given entirely to the thesis which should deal with a major problem requiring theoretical knowledge and some originality.

Student, Instructor, Library

There are several features of graduate work, not yet mentioned, which are of primary importance to its success: type of student, type of instructor, library and laboratory facilities. Graduate study is not for the average student no matter how industrious, nor for the lazy student even though gifted, since both have a detrimental effect on the able and serious student and on the quality of instruction. Graduate classes should not be conducted by men who have just passed the course the preceding year or by those to whom instruction is an article-by-article trip through a textbook. The instructor, in addition to a broad knowledge of the subject, should also have an interest in it. The students come for advanced study mainly because they are interested. If the instructor cannot stimulate and increase this interest or enthusiasm, something is wrong. One instructor, even though of outstanding competence, should not furnish all the teaching in a graduate program. The complexity of the various subjects, as well as the advantage of having the students exposed to several viewpoints, would call for at least three instructors. Personal and friendly contacts between student and instructor are of the greatest importance. A student who is not free to obtain advice or who does not feel himself in a friendly atmosphere cannot do his best work.

Graduate instruction requires an adequate library; a collection of standard handbooks and texts does not serve the purpose. There must be available the usual reference works, proceedings of native and foreign societies, native and foreign periodicals, research bulletins and the like. Without these the graduate program is only a make-shift. Adequate facilities should also be available for experimental work, both for small-scale models and for larger specimens. It is desirable that these laboratory facilities be separate from those regularly used for undergraduate courses.

Summary

Summarizing briefly, graduate studies in structural engineering, competently conducted along a carefully thought-out plan, with the necessary library and laboratory facilities, should impart to the student a broad knowledge of theory and of the behavior of materials and the ability to apply this knowledge to actual problems of difficult and unusual nature. It should also develop or stimulate the habit of independent thinking and of initiative.

An Elementary Photoelasticity Experiment

By R. T. LIDDICOAT

Associate Professor of Engineering Mechanics, University of Michigan

For several years in the first course in materials testing at the University of Michigan, a photoelastic test has been included to let students know that such a method has valuable application to experimental stress analysis.

Bakelite was first used as a specimen material because it is so sensitive optically. It has about 20 times the sensitivity of glass and about 5 times the sensitivity of celluloid. After a few tests, or after a short time interval, the specimens developed considerable residual strains and the conclusions drawn from the test were not too reliable.

As a possible means of eliminating the residual strain objection it was suggested that glass be used as specimen material, and to make up for lack of sensitivity by employing the "Babinet Compensator." Small retardations of light can be accurately measured by this method.

The employment of the Babinet Compensator in tests performed by undergraduate classes seemed to be unusual enough to justify a presentation of its description.

Specimens of the desired shape were accurately cut from plate glass. In preliminary study the specimens were found to be free of residual strain. One specimen consisted of a plain bar, Fig. 1, about a quarter inch square in cross section and about 5 inches long. The other specimen, Fig. 2, was also of rectangular section, with a single half circular notch.

In the experiments the students were given the optical constant for the material. On the plain bar they then obtained the stress at the extreme fibres due to known bending moment by computation and by optical or photoelastic methods. Good agreement between these values gave confidence in the testing method.

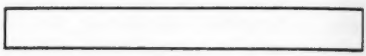


FIG. 1.

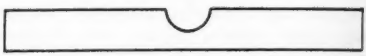


FIG. 2.

The second specimen with the notch was then loaded, and the stress obtained at the base of the notch by optical means. The nominal or computed stress for a beam of uniform section but of the same reduced net cross section was then obtained. The actual or optical stress divided by the nominal stress gave the factor of stress concentration, which was a main purpose of the test.

The Preliminary Theory

There was some review of the fact that light is transmitted by transverse waves, that it can be polarized, that a polarized beam of light passing through a plane-stressed transparent isotropic body is repolarized at each point on the body into two planes parallel to the principal stress planes. As these two polarized beams emerge they maintain the initial frequency but they are thrown out of phase by passage through the material.

The phase difference or relative retardation of the two emerging beams is proportional to the difference of principal stresses at the point. The emerging

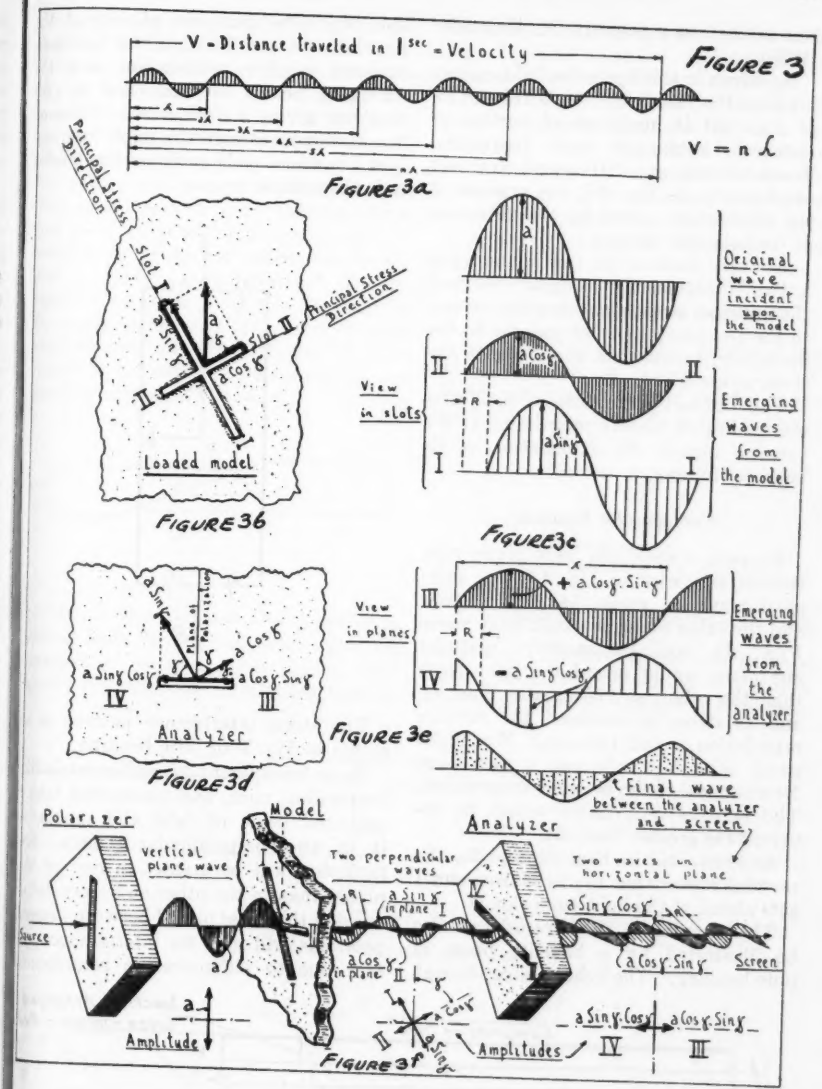


FIG. 3.

ght is repolarized by a so-called "an-lyzer" in a plane normal to the original olarized beam that entered the speci-en.

In the experiment under discussion the principal stress planes are looked upon as slots, following the method illustrated in Fig. 3. This illustration

was taken from a paper by N. Alexander (1936).

As shown in this figure the light emerging from the "analyzer" (slots III and IV of Fig. 3d) is made up of vectors of identical amplitude and frequency. These vectors are 180° apart and out of phase by R (Fig. 3e), the amount of the retardation caused by the difference of the principal stresses.

At every point on the free boundary of a two dimensionally stressed specimen the principal stress planes are one normal to the boundary and one parallel to the boundary, because on these planes the shear stress is zero.

The Babinet Compensator facilitates the reading of relative retardation at the extreme fibres. An explanation of its behavior follows.

Compensator Behavior

Suppose a specimen were given pure tension as shown in Fig. 4. One principal plane *ao* would have zero stress and the other plane *ob* would have stress P/A. In optically sensitive material one plane would retard the light more than the other, say *ob* greater than *oa*, and as stress is increased the relative retardation would increase. We might speak of a fast axis and a slow axis. Now suppose the stress were compression. The relative retardation would be reversed (*oa* greater than *ob*).

As illustrated in Figs. 3b and 3c, the reversal means that the light from slot I gets ahead of the light from slot II.

The meaning of the reversal can also be illustrated by a bakelite beam in pure bending. The light passing through the two slots (principal planes) at the neutral axis get through the specimen without relative retardation and the emerging beams are cancelled by the analyzer giving a dark band. Then on the compression side the light from say slot I is ahead of II while on the tension side the reverse is true.

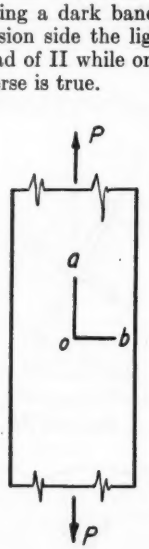


FIG. 4.

The stress interference pattern is as shown in Fig. 5 for pure bending.

Some transparent mineral crystals like tourmaline, mica, and quartz will take a polarized beam of light and repolarize it in two perpendicular planes. Retardation will be greater in one of the planes than in the other and a crystal of varying thickness placed between crossed polaroids will give an interference pattern due to differences in retardation.

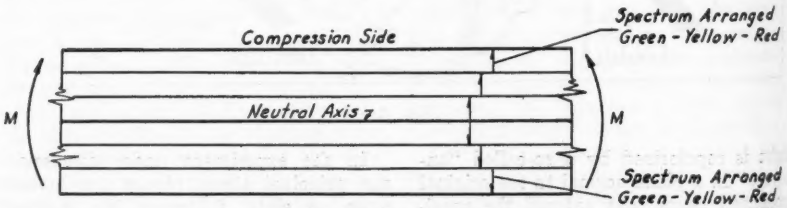


FIG. 5. Photoelastic pattern of beam.

In this sense the crystals act like stressed bakelite or glass.

By cutting wedges of quartz and placing them so that in one wedge slot I is perpendicular to slot I in the other we get a "Babinet Compensator," Fig. 6. The interference pattern of light through the superposed wedges is identical with that of a beam in pure bending. At a line $a-a$ where equal thickness of both wedges occurs the net retardation is zero and a "neutral axis" results. To the right of $a-a$ the pattern is like that of the compression side of a beam in pure bending and on the other side of $a-a$ the interference pattern is the same as for the tension side of the beam.

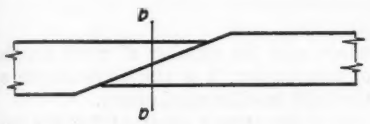


FIG. 6.

Now, if this Babinet Compensator is placed back of an unstressed, uniform rectangular section glass beam, and turned properly, the retardation pattern of the compensator appears as shown in Fig. 7. The distance d represents a relative retardation of one wave length.

If the beam is given pure moment M to cause compression in the top fibers, the glass becomes doubly refractive, and the total compression retardation above the neutral axis will be increased and shifted to the left as shown in Fig. 8. The shift is proportional to the retardation and stress.

The Experiment in Detail

An actual reproduction taken of the screen pattern is shown in Fig. 9. Measurements taken from this figure are recorded on the data sheet that follows.

$$\text{Stress } s = \frac{f}{d} K \frac{\lambda}{t}$$

λ = wave length of light
t = thickness of specimen
d = distance occupied by spectrum on screen
K = a constant for the material studied.

It is the boundary stress necessary to cause a retardation of one wave length in a specimen one wave length in thickness.

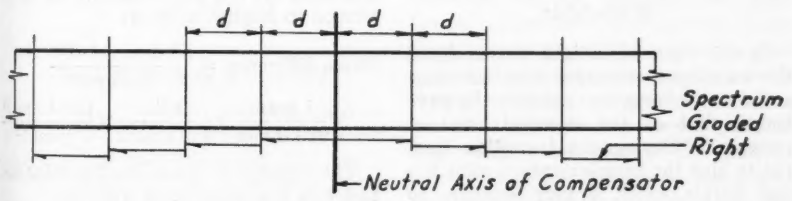


FIG. 7. Unstressed glass beam.

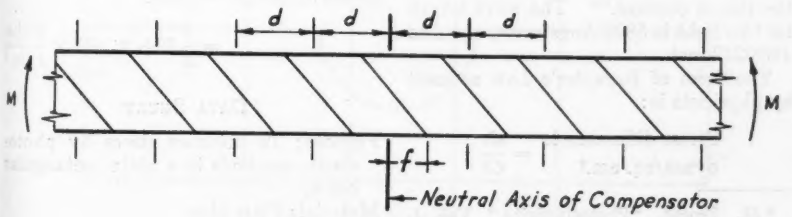


FIG. 8. Glass beam with moment M.

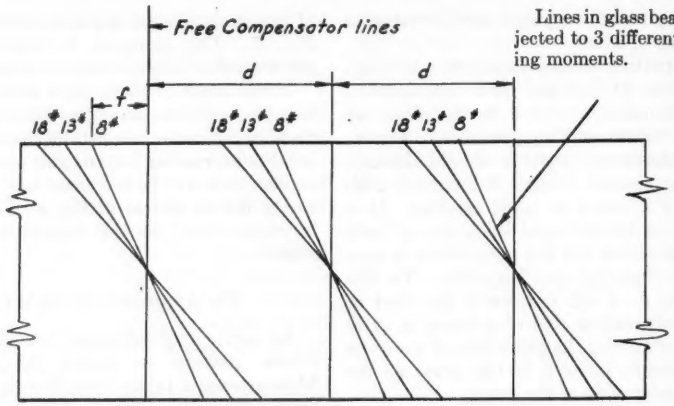


FIG. 9. Typical test pattern.

This formula for stress is Brewster's discovery that the stress is proportional to retardation.

To prevent confusion in computation the form of Brewster's law from which theoretical stress was figured was given to the class in the English system of units. The micrometer for measuring thickness and height were in inch units and the loads were in pounds.

White Light

In this work white light was used and the techniques employed were the same as for monochromatic light with the wave length that of the so-called "tint of passage." "During the transition from red to blue the complementary color is a dull purple which is very sensitive to small changes in $(p-q)$" (principal stress difference). "This color is called the tint of passage."* The wave length for this light is 5893 Angstroms, equal to .0000232 inch.

The form of Brewster's Law as used by physicists is:

$$\text{Stress difference in dynes/sq. cm.}^2 = \frac{n\lambda}{Ct}$$

where n is the number of wave lengths of retardation; λ is the wave length of the light used in centimeters.

C is Brewster's constant for the material, is in $\frac{\text{cm.}^2}{\text{dyne} \times 10^{13}}$. A value of 2.85 was used as C for the glass in this experiment.

t is the thickness of the specimen in centimeters. Since n is a pure number and since λ/t is a pure number, the conversion to English units is:

$$\text{Stress difference} = \frac{n\lambda}{t}\frac{\text{dyne} \times 10^{13}}{2.85 \text{ cm.}^2} \times \frac{1 \text{ gram}}{980 \text{ dynes}} \times \frac{1 \text{ lb.}}{454 \text{ grams}} \times \frac{(2.54 \text{ cm.})^2}{(\text{inch})^2}$$

The number of wave lengths retardation n in this experiment was f/d.

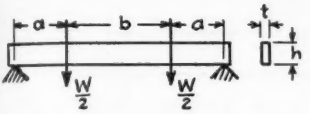
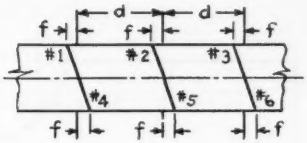
The final formula

$$\text{Stress difference} = \text{stress} = \frac{f}{d} 50.8 \times 10^6 \times \frac{\lambda}{t} \frac{\text{lbs.}}{\text{in.}^2}$$

DATA SHEET

Purpose: To measure stress by photoelastic methods in a plain rectangular beam.
Material: Plate glass
Condition: Annealed

* M. Frocht, "Photoelasticity," Vol. I, p. 169.



h = 0.249 in a = 1"

t = 0.253 in. b = 3¾"

$I = t\,h^3/12$ = 0.000328 in⁴

Stress = $K\frac{f\lambda}{d\,t}$ (A form of Brewster's Law) λ = Wave length = .0000232 inch

Tare = 3.5# d = Average color band distance = 1.20 in

K = psi stress that will cause one wave length retardation in material one wave length thick. $K = 50.8 \times 10^6$ #/in²

LOAD		BENDING MOMENT	NOMINAL STRESS	RETARDATION f							Optical Stress	Diff.
Added	Total W	$M = \frac{W\,a}{2}$	$S = \frac{M\,h}{2\,I}$	1	2	3	4	5	6	Aver.	$K\frac{f\lambda}{dt}$	%
5	8.5	4.25	1615	.46	.49	.48	.37	.37	.43	.43	1570	
10	13.5	6.75	2520	.72	.59	.68	.66	.68	.72	.67	2510	
15	18.5	9.25	3510	.94	.93	.81	.86	.87	1.03	.91	3500	

It will be noted that the nominal or computed stress is in good agreement with the optical stress found by the use of the Babinet Compensator. Theorists on elasticity prove that, if the material is isotropic, the nominal stress $Mh/2I$ is exact.

This agreement in values is in accordance with Brewster's discovery that retardation is proportional to stress differences.

Notched Specimen Experiment

The optical method was then used to obtain the factor of stress concentration in a notched glass beam, Fig. 10.

The image of the unstressed beam imposed on the compensator pattern appears as illustrated below.

If it is remembered that on the free boundary the principal planes (considered as slots) are one normal to and one along the boundary, shifted compensator lines due to loading can be interpreted.

The sketched image of the loaded specimen is shown in Fig. 11. The compensator can be "shifted" or "positioned" so that the free compensator lines remain vertical and with their original spacing, but the portions of the lines in the glass image, changed by stresses, can be brought to any desired position. The image in the glass of the compensator neutral axis AB can be brought to the low point of the notch where the principal stress slot is vertical as it is

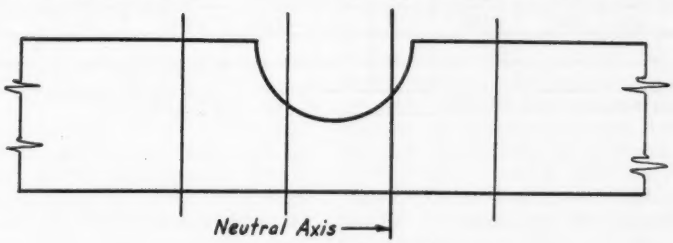


FIG. 10. Unstressed glass beam.

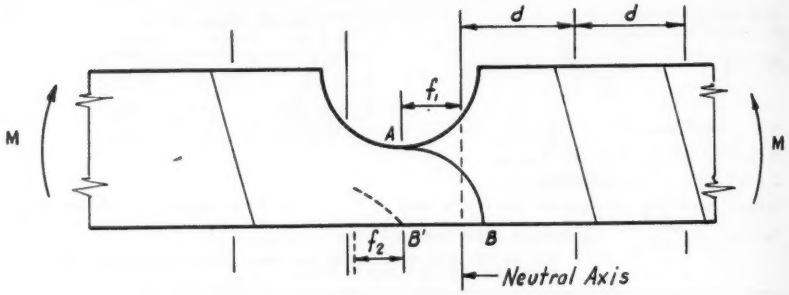
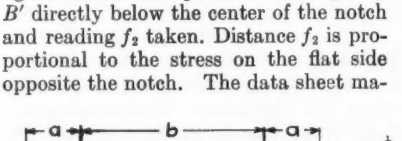


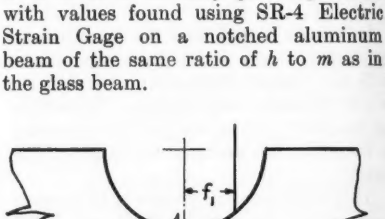
FIG. 11. Stressed glass beam.

in the compensator. The distance f is proportional to the stress at the base of the notch.

After measuring f, the compensator is again shifted until point B is brought to B' directly below the center of the notch and reading f_2 taken. Distance f_2 is proportional to the stress on the flat side opposite the notch. The data sheet material as obtained in this experiment is presented below.

The factor of stress concentration at the base of the notch averages about 1.17. This value is in fairly good agreement with values found using SR-4 Electric Strain Gage on a notched aluminum beam of the same ratio of h to m as in the glass beam.





h = 0.227" m = 0.494"

t = 0.255" I = t $h^3/12$ = 0.000248 $in.^4$

Stress $S_0 = K \frac{f \lambda}{d t}$ = 3720 x (f_1 or f_2)

LOAD		BENDING MOMENT	NOMINAL STRESS	RETARDATION		OPTICAL STRESS S_0		FACTOR OF STRESS CONCENTRATION S_0/S	
Added	Total W	$M = \frac{W a}{2}$	$S = \frac{M h}{2 I}$	Notch side f_1	Flat side f_2	Notch $\frac{K \lambda}{d t} f_1$	Flat $\frac{K \lambda}{d t} f_2$	Notch	Flat
#	#	"#	#/in^2	in.	in.				
5	8.5	4.25	1946	.63	.43	2340	1600	1.20	.82
10	13.5	6.75	3070	.95	.66	3530	2450	1.15	.79
15	18.5	9.25	4230	1.33	.83	4940	3090	1.17	.73

Average factor at base of notch 1.17, at flat side .79

Standards and the Young Engineer

By THOMAS D. JOLLY

Vice President in Charge of Engineering and Purchases, Aluminum Company of America

Standards will have an ever-increasing importance. They will play an expanding role in the field of engineering and manufactured goods, in commerce, and in many other new fields. The will ultimately affect the production and sale of all goods.

That statement was made in January, 1945, by a group of first-line business executives. The Secretary of Commerce had called them into conference to advise him on a program for post-war standards activities. The business leader of the conference was Mr. Charles E. Wilson, then president of the General Electric Company, now head of the Office of Defense Mobilization.

The prediction, I think, has been amply borne out in the five remarkable years since it was made. It is a commonplace that standardization has been an essential factor in giving us our mass production, our free national market, and, hence, our high standard of living. Today, however, standardization has been carried far beyond anything we have previously known. Standards are being applied to production processes in almost every field, from electronics to the packing and shipping of fruit. They are more and more permeating the entire fabric of our industrial economy.

A Dominant Characteristic of American Economy

On the company level, standardization is now accepted as a basic and indispensable tool of management. Standards activities may be carried out through a company-wide technical committee (as at General Motors and Detroit Edison); they may be the responsibility of an entire division or department (as at General Electric, Eastman Kodak and the Radio Corporation of America); or they may be delegated as a function of the engineering department (International Harvester, Chrysler Corporation). Regardless of how the standardization is carried out, its usefulness is no longer a question in the minds of company engineeers, purchasing agents and production men.

On the industry level, our trade associations and technical societies are doing important work in standardization throughout specific industries. Many of these organizations, particularly in engineering, have set up standards activities groups within their own structure. On the national level, American industry supports the American Standards Association as a clearinghouse of standards work. The ASA is one of 37 such national institutions throughout the world, and is the American representative among the 29 which make up the International Organization for Standardization. The federal government has a bureau and two divisions engaged exclusively in standards work. The armed services, which have always been leaders in the use of managerial standards ("Standard Operating Procedure" is one of the best-known phrases in military terminology), are now carrying out standardization projects of tremendous scope and importance, particularly in purchasing.

The points I want to make are simply these. Standardization is rapidly becoming the dominant characteristic of the American industrial economy. And

the importance of technical and managerial standards is more widely recognized today than ever before in our history.

It is my impression, however, that there is one place where the importance of standardization is not fully recognized. That is in the nation's engineering and business administration schools.

Standards Education in College

I do not mean to say that the professors and instructors of these schools do not understand or appreciate industrial standardization. I do not wish to imply that they are ignoring it. It would be almost impossible today to say very much on engineering subjects or management administration without taking up such matters as purchase specifications, manufacturing operations and processes, methods of inspection and testing, and the application of statistical methods to quality control. Examples of basic standards in these fields are those for screw threads, interchangeable machine components, and innumerable kinds of materials used in industrial production.

However, our American engineering schools, although they may deal with some specific subjects, such as standards for drawings and drafting room practice, with a few exceptions are not teaching industrial standardization as a specific course. Because they have failed to recognize the full significance of the standardization movement in this country, they are lagging behind industry and government in a field where they should be far out ahead.

These conclusions are based, first on an examination of the curricula of the colleges themselves, and, secondly, on an examination of a good many of the young engineers that they graduate semi-annually.

An inspection of the catalogs of our engineering and business administration schools shows that, with two exceptions, none is teaching any course or courses in industrial standardization. An examination of the graduate shows that he is a well and broadly schooled engineer. Never has any industry received such a well-trained engineer as ours is getting today. Nevertheless, he simply is not adequately informed on the theory, practice and application of standards, and his work shows it.

Why is this so? That is a question I must leave to you in education to answer. I do ask you, however, to skip the reason. "The curriculum is already overcrowded." If this subject has the importance that American industry seems to think it has (and it does), then that stock excuse has no validity.

The young engineer graduating into industry today is likely to lack, first of all, sufficient training in the fundamental art of writing standards specifications. He has not been drilled in the fact that standards should be written on a cooperative basis. The specifications he turns out, therefore, are likely to be badly written as specs, impractical, costly or impossible for the shop to follow. Or the young designer will create something special when a standard product, which will do as well or better, is readily available in the market at a great deal lower price. This means that his lack of knowledge of standards results in increased capital costs, money lying idle in stores inventory, and high maintenance expense.

The young engineer is likely, moreover, to have received standards training in his own field only. That would seem to be inevitable as long as standardization is taught as a subordinate part of other courses. Professors of engineering are specialists—very able specialists, to be sure, but specialists—in their own field. The highly integrated pattern of our industrial economy, of course, is such that standards training in one field only is quite inadequate. Standards enter into virtually everything a company designs, produces, inspects, sells and (most particularly) buys. The standards of definition, dimension, performance, testing and safety are all interrelated, and it is not enough to know one, two or even three of them.

The graduating engineer, finally, is likely to look upon standardization as merely a technical function, instead of standardization being as integral part of industrial and business management as well. He may have an adequate understanding of dimensional standards for steel sections for the building industry or of standardization of permissible stresses for steel structures, but he will be a rare young engineer if he has any conception of the administrative machinery by which standards are established and introduced into practice, or of the value of standards from the management point of view. If he has not learned this in college, there is, unfortunately, almost no place where he can be sent for special training in this field.

Standardization—A Powerful Economic Factor

Lack of knowledge of standards and training in standardization technique can handicap and perhaps personally embarrass the young engineer; but that is unimportant compared to the effect it can have on the company that hires him. Let me illustrate.

The literature of standardization is filled with hundreds of striking examples of great savings that companies have made through standardization. Here are two typical cases picked at random.

A company had been paying $60 per hundred for a certain type of bolt. It found that it could use a bolt complying with the American Standard that cost $9 per hundred.

A company found that it could reduce the number of metal washers it was using in its products from 1350 varieties to 150 standard types. It saved $25,000 in one year by doing this.

Now we can rejoice in the savings and added efficiency these examples demonstrate. But on soberer thought, the question arises: How did that happen? Why was the one company using a nonstandard bolt in the first place? How did the other company, in an age of standardization, come to be buying and storing so many unnecessary types of washers?

The answer is fairly obvious. Some engineer, or engineers, because there was no systematic standardization set-up in their company, designed them, requisitioned them, or ordered them. In one case, their error cost their company an annual waste loss of $25,000. In the other, it caused the company to pay $51 too much for every 100 bolts it used.

Such conditions may eventually be corrected—by someone who knows the importance of standardization. But the engineers who originally helped to create these conditions eventually rise to head their departments, divisions or even their companies. Unless they have mastered the theory and practice of standardization through practical experience on the way up, as is often the case, they may conceivably continue to permit conditions of this kind to develop on a far larger scale.

That such situations have been compounded on an industry-wide and national scale is becoming more and more apparent to all who study and report on the American industrial economy. *Factory Magazine,* for instance, has stated that American industry as a whole would gain about 650,000 man years of work a year if it used modern materials handling methods. The *Magazine of Building* recently estimated that more than a billion dollars a year could be saved by widespread use of dimensional coordination on the four-inch module. One prominent industrialist addressing the American Society of Mechanical Engineers last year declared that American business was losing about three billion dollars yearly in defective and rejected merchandise.

I said there are two exceptions to the statement that no American school teaches industrial standardization as a subject. They are Columbia University and Massachusetts Institute of Technology. Columbia's Department of Industrial Engineering, has, since 1947, held an annual course of 14 night classes on the practice

and application of industrial standardization. It is taught by Dr. John Gaillard, who is a lecturer on the Columbia faculty and a mechanical engineer on the staff of the American Standards Association. Dr. Gaillard also holds a week-long seminar on standardization twice a year, which has been attended by more than 100 conferees representing 73 organizations, including 63 private companies, two trade associations, an engineering college, five agencies of the armed services, and two foreign national standards bodies.

Last fall the Department of Business and Engineering Administration of Massachusetts Institute of Technology began the first college standardization course in this country that is taught as a full-term subject in a regular curriculum. It is conducted by Mr. Leo B. Moore, who was among those who attended Dr. Gaillard's first seminar on the subject back in 1947.

It is only a matter of time, I think, until we see such courses as these in most or even all our engineering and business administration schools. In normal circumstances, it would not matter vitally whether that time was a year away, or two, or five. Today, however, time is running short. We are in the middle of a world conflict in which it is not at all certain that we will win or even survive.

It seems obvious that to win that war, we must stop wasting our resources and make the best possible use of what we have. We must push to the limit the benefits of mass production—the supplying of a large volume of goods (both civilian and military) of sound quality at low cost.

Standardization can help us do all these things. It is not the sole remedy, certainly, for all our problems, nor even for all our production problems; but it certainly is an indispensable function that must constantly be applied to its full extent if American industry is to operate at anything like its potential level.

In developing this program, there is a tremendous job of education to do in government, in industry, in the armed services. Unfortunately, that educational program must begin with the educators themselves. The engineering and business administrative schools of this country, I am convinced, have both a responsibility and an opportunity in further exploring the industrial technique that has made this country productive and strong.

ANNUAL MEETING

June 23–27, 1952

Dartmouth College **Hanover, N.H.**

Retention of Mathematics in Mechanics

By JOHN W. CELL

Professor of Mathematics, North Carolina State College

A good point of departure in any consideration of teaching methods is an evaluation of the students to be taught. And since the first students we meet are freshmen, let us begin the discussion of Retention of Mathematics in Mechanics * with them.

The beginning freshman must learn to study. No longer can he get by with fifteen minutes of outside preparation on an assignment. He must increase his command of the English language as a basis for subsequent learning. He must master word problems. I trust that we all realize that we are, in a very real sense, teachers of English. And I suspect that you will realize as we proceed with this discussion that, as teachers of mechanics, you are all teachers of mathematics and physics as well.

The freshman's knowledge of basic algebra and geometry is likely to be fragmentary, if not actually faulty. He can probably transpose and cross-multiply and cancel (secant x/sine x = cat/i = a one-eyed cat). But often he does not understand that one can multiply both sides of an equation by a number and have an equivalent equation; that actually one can add fractions only when they have the same denominator; that there are laws of exponents for multiplication and division but not for addition and subtraction; and so on.

This freshman may be from almost any level of his high school class, depending in part on the mode of selection exercised by the individual college. I am told that it is quite possible for the poor student in high school to know very little more at the time of graduation than the good student knows as a high school freshman. Nevertheless, at many colleges their diplomas command equal consideration.

The Learning-Forgetting Curve: Every college freshman (like everybody else) has an individual learning-forgetting curve. Fig. 1 gives a schematic explanation of the learning and forgetting that a typical student may well have experienced when he begins his study of mechanics, and later, mechanics of materials. When we discuss retention of any topic we must realize that we are dealing with human beings and their normal frailties.

Influence of Advanced Students: Another thing that affects the freshman student and his retention is the information that trickles back from upperclassmen. If juniors and seniors tell him that they are using algebra and trigonometry in their study of mechanics, they exert a more telling influence than any sales talk from teachers of mathematics can do. If, however, advanced students tell the sophomores about being penalized in a subsequent course because they used methods of calculus when the teacher wanted them to *use the formula,* then the reverse effect is achieved.

Fundamentals: There is a tendency in many departments to treat each student as though he were going to do graduate

* This paper contains a part of the writer's presentation at the ASEE Summer School for Mechanics Teachers held at Iowa State College in September of 1950. While the remarks are addressed to the subject of mechanics, the ideas are equally applicable in other fields of engineering.

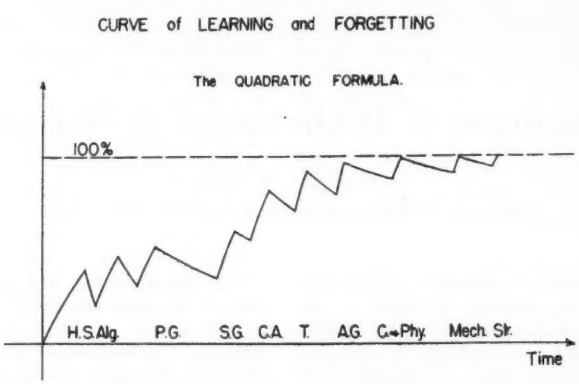


FIG. 1.

work in their fields of study. The teacher of mechanics of materials, for instance, is tempted to anticipate some of the subject matter taught in the senior courses in civil engineering. He finds time for the advanced topics by neglecting some of the fundamentals (as well as the uses of mathematics). This tendency to over-reach immediate topics is not surprising, since all teachers naturally like to teach the more advanced work. This complaint suggests another: It is unwise to try to exhaust every topic the first time it appears, as though it would not be treated again in other courses. For example, modern texts in physics contain all the information that was there when you and I took that course with the addition of new chapters on electronics and radioactivity and other recent ideas. Some of the problems in those physics texts dealing with mechanics and strength of materials would be more appropriate in the engineering courses that follow. This same criticism is valid for some recent texts in mathematics. They have all the material that was present thirty years ago, with the addition of new topics that engineering professors want us to teach; but we have no increase in time to teach the new material. I mention these two common defects in teaching because I believe that the piling on of too *much* or too *advanced* course material is an actual deterrent to remembering the fundamentals.

Continuity of Instruction: One device that can aid tremendously in retention is that of continuity of instruction. For example, in the freshman course in analytic geometry we teach the locus-derivation method for writing equations of curves. If we teach it with the realization that it is the student's first introduction to what is later to be stressed as the engineering or scientific method for the analysis and solution of engineering problems, then the student will be more receptive later to the engineering method.

This idea of continuity of instruction can take many forms. One approach would be for us to ask whether various modes of solution as traditionally taught really aim toward over-all objectives. For instance, consider the short-cut. It may be that a method of solution that takes several more steps and more time is a better method of solution than the short-cut. If so, should we cling to the time saver? One example of this can be had from solid analytic geometry. There is a good formula in the texts for finding the acute angle of intersection of two lines. Fig. 2 suggests a problem in which the student could apply this formula. But he can also solve the problem

(of finding the angle between the two guys) from another figure and by the use of the law of cosines. When he draws the required figure and applies the law of cosines, he is developing skill in a basic technique and in the manipulation of fundamental ideas. I believe that his finding the actual amount of the angle is not so important as the development of skill inherent in the longer method.

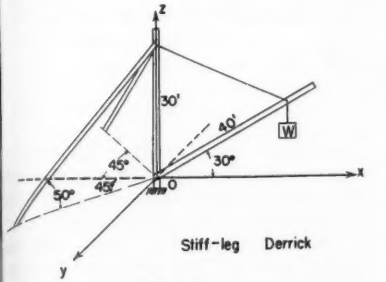


FIG. 2.

This particular figure could be used even in high school in teaching solid geometry, for the same reason that I like to use it in my freshman classes. It suggests other things besides the stated problem. It may stimulate the learning and retaining process because it implies future use of the topic at hand, and because it involves something that may be of much more interest to the student than the mathematics being learned. Judicious use of problems that foreshadow future ones (but do not teach subsequent ideas) can certainly stimulate classroom attention and the resultant retention of ideas. Apropos of this same figure, teachers of mechanics would do well to make specific reference to the law of cosines when they start teaching the vector law. Perhaps half of the students of every class (because of their learning-forgetting curves) need a brief review of the law of cosines, and the teacher would help their retention by careful use of this law rather than by starting them afresh with a new idea which they will equally forget.

Outlines: The periodic construction in class of an outline of the basic ideas already learned in a course, together with anticipation of what lies ahead, can help in this matter of retention. After more than twenty years, I well remember the outlines that appeared in Professor Seely's class in Strength of Materials, always with a diffierent sequence of oral questions that helped us to fill in the details of the outline.

Three Kinds of Mathematical Knowledge: One type of mathematics is that which the student should have at his finger tips, such as the quadratic formula, the trigonometric expansion for $\sin (A + B)$, or the derivative of $\sin u$ with respect to x. A second kind is that knowledge which the student should know where to find when he needs it. And a third body of knowledge is that which the student ought to be able to develop and *frequently should develop* on the basis of the ideas that he himself commands. This *habit* of reaching for tables of formulas at every opportunity certainly is not calculated to give to the student confidence and maturity. For example: Suppose that we were faced with the need of replacing $\cos 11x \sin 4x$ by a sum or difference of trigonometric functions. Every text on trigonometry and every set of tables gives a formula for doing this. But the following procedure has merit:

$$\sin (11x + 4x) = \sin 11x \cos 4x + \cos 11x \sin 4x$$
$$\sin (11x - 4x) = \sin 11x \cos 4x - \cos 11x \sin 4x$$

We subtract and obtain $\sin 15x - \sin 7x = 2 \cos 11x \sin 4x$, which is essentially the required formula. I can well remember seeing Dean Carmichael at the University of Illinois work out just such a relationship as he taught a class in advanced mathematics. I learned from that peerless teacher something of the art of basing instruction on fundamentals, and on the progression from the known fact to the desired solution. No teacher

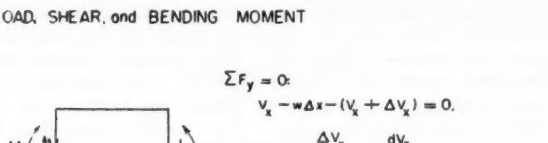

LOAD, SHEAR, and BENDING MOMENT
$\Sigma F_y = 0$:
$V_x - w\Delta x - (V_x + \Delta V_x) = 0$.
M_x
V_x
$M_x + \Delta M_x$
A
$w\Delta x$
$V_x + \Delta V_x$
Δx
$\frac{\Delta V_x}{\Delta x} = w$, $\frac{dV_x}{dx} = w$.
$\Sigma M_A = 0$
$M_x + V_x\Delta x - w\Delta x\frac{\Delta x}{2} - (M_x + \Delta M_x) = 0$,
$V_x - w\frac{\Delta x}{2} - \frac{\Delta M_x}{\Delta x} = 0$,
$\frac{dM_x}{dx} = V_x$

FIG. 3.

need apolgize for making each step utterly clear, so long as he bases his presentation on the immediate fundamental. More important as a consequence of such instruction is that it engenders thinking and insight, and no amount of handbook referencing can do this.

The delta process, as taught in every course in calculus, is a good example of what mathematicians regard as a fundamental topic, and is one which may be considered profitably as we discuss continuity of instruction. Teachers of calculus utilize this process as the basis of almost every derivation throughout all of differential calculus. We obtain the derivative of a product by its use, the derivative of sin u, and so on. Thus the student is exposed repeatedly to this idea. His retention of mathematics, therefore, is greatly stimulated if later in undergraduate engineering the delta process is used wherever feasible. Fig. 3 is a typical figure taken from a text on Mechanics of Materials, except that the dimensioning is that of the delta notation rather than that of the differential. Derivations by both methods are equally correct. But proof by the delta process affords continuity of instruction. Moreover, *the delta-process derivation does not give rise to the false impression that certain approximations have been made "by neglecting infinitesimals of higher order."*

Continuity vs. Diversity: Mathematics teachers spend some time on moments while showing applications of integration. Simultaneously the physics teachers are discussing the idea of centroid and moment of inertia. And mechanics teachers, more than any others, use moments. How much time and emphasis are the proper function of each department involved in this instruction, and how much overlapping is good? And, more important still, is there continuity of instruction, or is there such diversity of presentation that the student is bewildered? Should mathematics teachers assign composite bodies and require the students to compute the centroids and moments of inertia? I do not think so; that is material that mechanics teachers properly stress. Should the physics classes utilize problems in motion such as that of a wheel with spokes for which the appropriate moment of inertia is computed by sundry rules? Again it seems to me that such ideas lie in the province of mechanics. Ideally, these three departments should synchronize their courses, leaving to the mechanics department the task of welding the total knowledge. If we have three radically different approaches, we will only promote the evil of "compartment" learning. The trend to appoint committees within a college to correlate course content and teaching can have salutary results.

Quizzes and Visual Aids: There are other devices that can aid the student in retention of knowledge. One of the best of these is the cumulative quiz, which we are using with good results at N. C. State College. On our mathematics quizzes about half the questions are on current material, and half deal with material that has preceded in the same term. Furthermore, we are learning how to slip in questions involving basic knowledge from earlier courses in the guise of problems on current material.

Still another method of aiding retention is the use of visual aids of various types—but only as teaching *aids.*

Interchange of Teachers Between Departments: Many teachers could be better prepared to help the student's retention if they had clearer insights into subsequent uses of the material they are teaching. The occasional interchange of teachers between related departments with frequent conferences attended by the exchange teachers and their colleagues can have a remarkable effect. Even frequent committee sessions on interrelating subject matter may be beneficial to the participants in terms of better insight into related material.

Summarization: I am aware that this discussion is not exhaustive. Indeed, no teacher can impose upon any other a total method. Each teacher, through his knowledge of the entire field of which he is a part (in this case engineering education), and through experience, develops his own teaching philosophy and techniques. I hope, however, that we can all agree upon the principles herein proposed. We ought to teach our several courses so that we incite a maximum amount of retention. We ought to teach so that the word filters back to the freshman and the sophomore that he had better learn his mathematics, his physics, and his English. We ought to seek continuity of instruction throughout the entire engineering curriculum. We ought not always to teach the short-cut method. We ought to teach toward objectives and not as though our course will have the last word on the subject. And we ought to strive for a better understanding of related material.

DR. DUGALD C. JACKSON

Dr. Dugald C. Jackson, President of the American Society for Engineering Education 1906–07, died on July 1, 1951 at his home in Cambridge, Massachusetts.

Dr. Jackson graduated from Pennsylvania State College in 1885 and for two years served at Cornell University as a fellow in electrical engineering. After sixteen years on the faculty of the University of Wisconsin, he joined the faculty at the Massachusetts Institute of Technology where he was Head of the Electrical Engineering Department for his full term of service.

Dr. Jackson served as a lieutenant-colonel of engineers during the first World War and in 1929, President Herbert Hoover appointed him as a representative of the United States at the World Engineering Congress in Tokyo.

In 1931 Dr. Jackson was awarded the Lamme Medal by the ASEE, one of many honors he received in his long and distinguished career.

TIMELY TIPS

Graphical Representation of Kinetic Energy Changes for an Adiabatic Irreversible Expansion

By WILLIAM B. NORDQUIST

Assistant Professor of Mechanical Engineering, University of Washington

The problem of interpreting a temperature-entropy diagram for an irreversible adiabatic expansion of steam in a nozzle is baffling to many students of Elementary Thermodynamics. Inspection will show that at any point, if momentary equilibrium is assumed, the steam will be drier than for the corresponding pressure point had the steam expanded isentropically. Drier steam means an increased specific volume, which, for a given nozzle cross-sectional area, would indicate a greater steam velocity. This argument, if carried through to the exhaust pressure, would lead to the paradoxical conclusion that friction will increase the useful work output of the vehicle.

The purely mathematical approach to this phenomenon, in terms of differential equations of reversible processes, is of small value. The average student is either being currently bewildered by the calculus, or, having recently completed the course, is not yet too sure of what he has learned or how he can apply it to a physical problem. From the standpoint of effective teaching, it is much more satisfactory to substitute a graphical analysis, even though it lacks, to a small degree, the complete rigorousness of an abstract mathematical approach.

The following method has been used quite successfully:

Assume that a perfectly designed frictionless nozzle (Fig. A) has concentric rings 1′—2, 2′—3, 3′—4 welded to it as shown. The steam entering at 1 would expand isentropically from $1' \rightarrow 1$, become momentarily turbulent from $1' \rightarrow 2$, expand isentropically from $2 \rightarrow 2'$, again becoming turbulent from $2' \rightarrow 3$, etc.

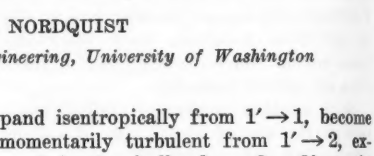


FIG. A

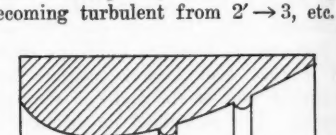


FIG. B

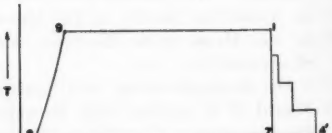


FIG. C

Now, considering the T-S diagram (Fig. B), the increase in kinetic energy of the steam as it expands from 1 to 1′ will be the entire area, both plain and dotted, to the left of 1—1′. As the steam flows past the ring, a portion of the useful kinetic energy (in this case the dotted area to the left of a—1′) will be changed to turbulent energy. For simplicity, it is assumed that the energy of this turbulence is dissipated and absorbed by the vehicle isothermally, and that as the steam leaves the down stream side of the welded ring, it is again in quasistatic equilibrium with point 2 in Figure B representing its state. From the General Energy relationships of an adiabatic expansion, the dotted area to the left of a—1′ is equal to the dotted area under 1′—2. The steam is again expanded isentropically from 2 → 2′ and then past ring 2′—3. As the vehicle reaches point 3, its useful kinetic energy is the sum of the areas to the left of 1—a and 2—b. The dotted areas to the left of a—1′ and b—2′ have been completely used up as turbulent friction and reappear as isothermal heat transfers under lines 1′—2 and 2′—3. The above arguments are repeated until the steam emerges from the nozzle at point 4′.

The enclosed area 1, 4′, 7, 8, 9, 1 of Figure C is representative of the useful kinetic energy of the vehicle leaving the nozzle, plus what had at one time been turbulent energy. This turbulent energy is proportional to area 1, 4′, 5, 6, 7, 1 (Fig. C). Subtracting this latter area 1, 4′, 5, 6, 7, 1 from the former area 1, 4′, 7, 8, 9, 1, will leave an area representative of the useful kinetic energy of the jet.

It can be seen from this that, because of turbulence and friction, the increase in kinetic energy, had the steam expanded isentropically from pressure 1 to pressure 7, is greater than the irreversible increase in kinetic energy by area 4′, 5, 6, 7, 4′.

By this means of presentation, several additional interesting facts can be pointed out to the students.

1. Not all of what was once turbulent energy is wasted. Almost all of the area 1, 4′, 7, 1 (Fig. C) was resalvaged for useful work.
2. Friction and turbulence in the adiabatic case are not nearly as disastrous at high temperatures as at low temperatures. Note that almost half of the area to the left of a—1 was re-used as useful kinetic energy, but only a small percentage of the area to the left of c—3 can be salvaged.

Occasionally, an exacting student will object to any sort of line from 1′ → 2, 2′ → 3, etc, on the T-S diagram because of the non-homogeneity of the vehicle. Usually, he can be placated by considering these isothermal lines to be made up of points representing momentary equilibrium of the vehicle as it is absorbing the effects of the decadence of the turbulent energy.

Cooperative Division to Hold Third Annual Mid-Winter Meeting

The Cooperative Division of the ASEE will hold its Third Annual Mid-Winter Meeting at Northwestern University, November 8th and 9th. The program is planned to be a part of the Technological Institute's program in the Centennial celebration of Northwestern University this year.

Minutes of Executive Board Meeting

A meeting of the Executive Board of the American Society for Engineering Education was held on Monday, June 25, 1951 at Michigan State College, East Lansing, Michigan. Those present were: F. M. Dawson, *President,* H. H. Armsby, A. B. Bronwell, L. E. Grinter, G. A. Rosselot, C. L. Skelley, F. E. Terman, and B. Bowen.

Report of the Secretary

The Secretary presented a written report summarizing the year's activities. He reported that the General Education Board grant to the Southeast Section for research fellowships had terminated and that the balance of the funds will be returned to the General Education Board.

Report of the Treasurer

The report of the Treasurer was presented, including the tentative annual audit. The Treasurer stated that the income and expense statement showed a small net addition to surplus during the past year. However it would be necessary to draw upon the Special Projects Reserve Fund to the extent of approximately $400 for special projects conducted during the year.

There was a discussion as to how to handle the ECRC accounts, owing to the deficit which is offset by the inventory of unsold publications. A motion was passed to establish a revolving fund, with the following provisions: (1) The Executive Board is to set up an account for the Engineering College Research Council, (2) To this account will be transferred the balance in the ECRC reserve amounting to $1,315.03, (3) The Executive Board voted an additional $400 from the Special Projects Reserve to the new ECRC revolving fund, (4) All current cash deficit or unpaid bills for the year ending June 30, 1951, shall be charged against this new account (it is estimated that these amount to $1,635), (5) It is the desire of the Executive Board and of the Parent Society that the Research Council use this new account as an operating account to which will be deposited all receipts and from which all expenses will be paid, (6) The Executive Board also will deposit to this revolving fund the annual budget appropriation to the ECRC.

The Treasurer reported that the proposed budget for 1951–52 is considerably more stringent than the budgets of preceding years, owing to rising costs. The Society has been notified of a nine per cent increase in costs of publication of the JOURNAL. This item alone adds approximately $2,000 to the annual expenses of the Society. A motion to approve the budget was passed.

It was voted that a committee of the Society be appointed to solicit advertising for the *Journal of Engineering Education.*

Report of the Vice-Presidents

Vice-Presidents Armsby, Grinter, Terman, and Rosselot presented written reports on the activities of the Society's Sections and Branches, Divisions, Administrative Council, and Research Council. These are summarized in the minutes of the General Council meeting of June 25, 1951.

Fall Meetings of ECRC and ECAC—1951

The Board voted to hold the Fall meetings of the General Council, ECRC and ECAC in Houston, Texas, after the Land

Grant College meeting, which is to be held November 13–14.

Control of Questionnaires Used by ASEE Members Making Surveys

The Board discussed the problem of the burden placed upon administrative persons and faculty members by the numerous questionnaires which have been sent out by members in the name of the Society. It was the consensus of opinion that the Society should not attempt to control questionnaires as long as the ASEE name is not used, but that the problem should be brought to the attention of the members of the Society.

Location of 1953 Annual Meeting

The Board voted to hold the 1953 Annual Meeting at the University of Florida, the dates to be worked out with the host institution.

Dues of Faculty Members on Leave in Industry

The Secretary presented a letter which raised the question of dues of faculty members who are on leave from a university or college to work in industry. There is a standing regulation of the Executive Board that only members whose full-time activities are devoted to university work are entitled to the lower dues status. It was decided that faculty members on leave for short periods might be continued with dues status unchanged, but that if they continued their outside affiliation for a period of more than a year, they should be given the dues rating of industrial people.

Application for Affiliate Institutional Membership

The Board voted to approve the applications of Wentworth Institute and RCA Institutes for Affiliate Institutional Membership.

Additional Agenda Items

The following items were considered by the Executive Board and referred to the General Council for appropriate action. They are explained in the minutes of the General Council meetings of June 25 and 27, 1951.

1. Unity of the Profession.
2. The Society's participation in the civil defense program.
3. Resolution on postage stamp commemorating the centennial of engineering.

A meeting of the Executive Board of the American Society for Engineering Education was held on Wednesday, June 27, 1951, at Michigan State College, East Lansing, Michigan. Those present were: F. M. Dawson, *President,* H. H. Armsby, A. B. Bronwell, L. E. Grinter, G. A. Rosselot, C. L. Skelley, F. E. Terman, S. C. Hollister, J. H. Lampe, and B. Bowen.

Application for Technical Institute Branch

A motion was passed authorizing the Milwaukee School of Engineering to form a Technical Institute Branch. The Executive Board requested that the designation Technical Institute Branch be used in order to differentiate between branches of the Society in technical institutes and those in engineering colleges. It was pointed out that it has been the policy of the ASEE to prohibit any Branch from using this affiliation for advertising or public relations purposes.

New Projects

The Board voted that the officers of the Society be authorized to seek funds for two projects: (1) a survey of adequacy of standards in engineering education, and (2) the current project of the Committee for Improvement of Teaching.

Institutional Membership

Dean Hollister proposed that the Board authorize a study to be instituted by the officers relating to the development of Associate Institutional Memberships among industries. The Secretary reported that the Society has only six Associate Institutional memberships. It

was felt that now was an opportune time to get industry to take a more active part in the Society. No action was taken.

Advertising

The Executive Board voted to authorize a committee to solicit advertising for the JOURNAL.

Unity of the Profession

It was moved and passed that the following resolution be recommended for favorable action to the General Council.

"Your Executive Board believes that ASEE should be included in any group of societies which may unite in establishing any unity organization such as is contemplated in the report of the exploratory group representing this and several other societies. The Board recommends that ASEE cooperate fully with the professional engineering societies which are endeavoring to promote increased unity of the engineering profession, and that ASEE join in the formation of the proposed unity organization, *provided* that it is so constituted that ASEE as a constituent member society may retain its present requirements for membership."

Centennial Engineering Stamp

The Board voted to recommend to the Council endorsement of the issuance of a postage stamp commemorating the centennial of engineering, as proposed by the American Society of Civil Engineers.

Committees

It was voted to discharge the Committee on Industrial Safety, Hygiene, and Fire Prevention, as recommended by the Committee's officers.

The Executive Board voted to authorize the appointment of a Committee on Civil Defense.

Registration Fee at Annual Meeting

The Executive Board considered the problems of financing future Annual Meetings of the Society and recommended to the Council the adoption of a plan which is stated in the Council Minutes of June 29.

ECRC Committee on Contract Relations

The letter from the ECRC, respecting the appointment of a committee to represent the American Society for Engineering Education to study the problems of college and university contract relations with the federal government was discussed by the Executive Board. The following motion was approved.

"There is authorized the appointment of an advisory committee of the American Society for Engineering Education, responsible to the Research Council, to study intensively the problems of college and university contract relations with the federal government. This committee would be charged:

1. To prepare a statement outlining the consensus of university requirements;
2. To implement this statement by appropriate presentations in cooperation with other university groups concerned;
3. To discuss with federal officials on any problems of immediate concern during the period in which the statement was in preparation; and
4. To advise the appropriate agencies of the federal government regarding the existence and functions of the committee.

It is understood that the statement of university requirements should be circulated among all institutional members of the Society for their comments before publication."

Committee on Sections and Branches

Dr. Armsby presented the following recommendation of the Committee on Sections and Branches:

1. That the Committee on Sections and Branches be continued as now constituted.

2. That each Section be authorized to indicate the definite geographic area for which it wishes to assume responsibility, that the Chairman of the Committee on Sections and Branches conduct negotiations as required to avoid duplication and to insure that the entire country is covered; and that the resulting areas be submitted to Council for approval.
3. That following approval of definite geographic areas, each applicant for membership be given opportunity to indicate the Section with which he or she desires to affiliate, and that the same opportunity be given to all present members not already affiliated with a section.

The proposals were approved by the Executive Board.

Invitation to Membership on the Cooperating Committee of AAAS

It was moved that the officers be authorized to take appropriate steps to comply with the request from the AAAS Cooperative Committee on the Teaching of Science and Mathematics, if in their judgment such cooperation is desirable. The motion was passed.

Appointment of the Secretary

The Board voted to re-appoint Arthur B. Bronwell Secretary of the Society for the year 1951–52.

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

College Notes

Engineering professors and instructors at the **State University of Iowa** have been spending time lately brushing up on their teaching theories. The results, the professors admit, have been surprising. Originally planned as a refresher course in the fundamentals of teaching, a program was designed for younger staff members of the university's college of engineering. It was part or a national effort sponsored by the American Society for Engineering Education and consisted of weekly meetings and panels extending from February to May. The program was carried out in cooperation with the university's college of education, which supplied many speakers on educational theory. On alternate weeks, the engineering staff formed a panel to discuss what the educators had presented the week before.

More than 5200 engineering research projects, representing annual expenditures of over $50.5 million, are now active in the engineering schools of American colleges and universities. These figures highlighted the bi-annual report of college and university research in the engineering sciences, prepared by the **Engineering College Research Council** of the American Society for Engineering Education, and released by Gerald A. Rosselot, chairman of the Council and director of the State Engineering Experiment Station at the Georgia Institute of Technology. The research projects, which cover all fields of engineering, represent the work of more than 11,500 faculty, graduate students, and research engineers, Dr. Rosselot reported. With only a few exception, he said, the projects are devoted to fundamental studies. Many are sponsored by federal government and state and industrial groups, but an important part of the activity is supported by general funds available for the educational programs of the institutions.

Minutes of General Council Meeting

A meeting of the General Council of the American Society for Engineering Education was held on Monday, June 25, 1951, at Michigan State College, East Lansing, Michigan. Those present were: President F. M. Dawson, H. H. Armsby, L. E. Grinter, G. A. Rosselot, F. E. Terman, C. L. Skelley, A. B. Bronwell, T. Saville, C. J. Freund, C. E. MacQuigg, R. S. Glasgow, C. A. Mockmore, L. O. Stewart, H. C. Spencer, F. J. Lewis, W. A. Koehler, T. T. Aakus, G. K. Palsgrove, M. T. Ayers, M. P. Capp, D. S. Clark, J. H. Rushton, C. E. Bennett, H. A. Bolz, R. L. Shurter, J. C. McKeon, H. W. Barlow, W. H. Carlson, H. H. Wheaton, R. D. Landon, H. K. Justice, H. R. Beatty, E. R. Walker, K. L. Holderman, L. R. Blakeslee, E. R. McKee, M. B. Robinson, W. M. Lansford, E. C. Clark, J. E. Thornton, R. Z. Williams, G. B. Hoadley, E. Laitala; and invited guests were: J. A. Hannah, J. Weil, C. Muhlenbruch, W. P. Kimball, L. G. Miller, W. R. Woolrich, and B. Bowen.

Report of the Secretary

The Secretary submitted a written report on the activities of the Society during the past year. He stated that the Society had received a letter from the Secretary of the State of Illinois that its request for incorporation as a non-profit corporation in the State of Illinois had been approved.

The Secretary announced the renewal of the agreement with the Westinghouse Educational Foundation, providing for a continuation of the Westinghouse Award on the same basis as the original contract.

The Secretary announced that approximately 550 new members were added to the membership rolls during the past year and that the resignations and deaths total 327. He stated that it appears likely that the membership is reaching a saturation point, but that there were certain areas of potential membership which had not been heavily canvassed. Motion to approve the Secretary's report was passed.

Report of the Treasurer

The Treasurer presented the annual audit, which showed a probable surplus of approximately $1100 in the year's operations. He stated that $400 would be used out of a Special Projects Reserve Fund which had been set up the previous year. He also stated that the General Education Board Research Grant to the Southeast Section of the ASEE expired in June of 1949 and would therefore be terminated. This would involve a refund to the General Education Board of $13,229, which would decrease the cash position of the Society by this amount.

The Treasurer presented the budget for 1951–52. He stated that the printing firm publishing the JOURNAL had announced a nine per cent increase in publication costs. This, together with other increased costs of operation, would make it appear as though the Society would operate at a barely balanced budget for the coming year, with no appropriation for special projects which might arise during the year.

The President summarized the report by stating that the financial position of the Society during the past year was quite satisfactory, but that it appeared probable that the finances would be considerably more stringent in future years if the present dues structure is maintained. A motion was passed to accept the Treasurer's report.

Report of the ECRC

Dr. Rosselot, Vice-President of the ASEE in charge of the Research Council, reported briefly on the two major projects which the Council had undertaken during the past year. These include: (1) a bi-annual *Review of Current Research,* and (2) the survey of University Research Potential. The latter was a cooperative endeavor with the Research and Development Board. Both publications have been completed and will be made available to the Society membership at a price to cover printing costs.

He reported that the bi-laws of ECRC had been amended to permit the formation of geographical sections of the ECRC and that a petition for the formation of a section in the Southeast Section had been presented.

He reported that the inventory of the Review of Current Research and the University Research Potential publications assured the Research Council of an income next year which would place the Council in a sound financial position.

Unity of the Profession

Dean Saville outlined the proposal for the Unity of the Profession organization. He stated that in his opinion the General Council should present some definitive recommendations which he could present to the Planning Committee as representing the official opinion of the Council.

Dean Freund emphasized the desirability of the ASEE's participation in the Unity organization in order to get a single spokesman for the entire engineering profession. Dean Saville stated that it is quite likely that the Planning Committee will consider other plans than those originally proposed and that the entire planning is still in the fluid state, but that it was necessary for ASEE members to make their wishes known now if they wished to have any influence in shaping the basic structure of the organization.

Engineering Manpower

Dean Saville summarized the accomplishments of the Engineering Manpower Commission. He stated that the Commission had received excellent cooperation from Mrs. Rosenberg, Assistant Secretary of Defense. However he stated that the views of Secretary of Defense Marshall on the problem of technical manpower are apparently opposed to those of Mrs. Rosenberg and that considerable opposition might therefore be anticipated from the Secretary of Defense.

Other Relations with Government

Dean Saville reported briefly on the National Science Foundation and the Point Four program. He stated that a program was being considered by the Office of Scientific Manpower for the furloughing of faculty members to government agencies on a two year rotation basis. This proposal is still in the tentative stage.

Report of Vice-President Armsby

Vice-President Armsby presented his written report. He spoke briefly of the effective cooperation which has been achieved through the formation of the Committee on Sections and Branches. He summarized the work of the regional conferences which had been organized by the ASEE Committee on Atomic Energy. The Atomic Energy Committee of the ASEE has recommended to the Atomic Energy Commission that a bibliography be published on basic materials which would be of interest to engineering educators. The Committee also recommended to the Atomic Energy Commission that they sponsor the publication of a source book on atomic engineering along the general lines of Gladstone's Source Book. The Atomic Energy Commission has agreed to undertake both projects.

Report of Vice-President Grinter

Vice-President Grinter reported on the summer school program for the past year,

including those sponsored by the Engineering Drawing Division, Humanistic-Social Division, and Mechanical Engineering (Thermodynamics) Division. He spoke of the outstanding success of the two summer schools which were sponsored by sections of the Society. These were the Fontanna Summer School of the Southeast Section and the University of Wisconsin Summer School sponsored by the North Mid-West Section.

He reported on the accomplishments of the Committee on Improvement of Teaching and stated that this Committee had met for two days prior to the Annual Meeting to consolidate its findings and prepare reports for presentation at the General Session. He stated that the Committee will now embark upon the preparation of a final report.

Report of Vice-President Terman

Vice-President Terman outlined the work of the ECAC during the past year. He stated that the Committee on International Relations of the ECAC had undertaken two major projects, one of these being the scheduling of an International Night Dinner at the Annual Meeting at Michigan State College. This dinner was attended by a number of engineering educators of foreign countries who were invited by the chairman of the Committee. The second project was the formation of a Commission on Engineering Education to visit Japan and consult with educators and the Japanese government on engineering education. He also outlined the Annual Meeting programs on engineering manpower and the executive session of the ECAC which were scheduled for the Annual Meeting.

Membership Qualifications in the Society

The Secretary stated that the constitution of the Society specifies the requirements for individual membership in the society as follows: "Persons who occupy responsible positions in engineering instruction, research or practice," and then leaves the door open with the additional stipulation "and other persons interested in engineering education." He stated that this wording of the constitution gave the Secretary's office no authority to question the membership qualifications of anybody applying for membership in the Society and that numerous applications had been received from persons requesting membership in the Society whose affiliations and interests were not in any way associated with engineering education or engineering. He stated that the purely mechanical routine of submitting the list of new members to the General Council for approval did not constitute any basis of selection, since a majority of the Council members approved the list without discrimination. Professor Clark suggested the advisability of establishing minimum qualifications for membership in the Society in order to clarify the eligibility of applicants. No action was taken.

Cooperation with High Schools

Dean MacQuigg mentioned the close cooperation between several of the engineering colleges in Ohio and high schools throughout the state. He stated that this had been effective in increasing engineering enrollments and also in conveying to the high school teachers the educational needs of the universities and colleges. Dean Freund raised the question as to the possibility of soliciting membership of high school teachers in the ASEE in order to further this objective.

Civil Defense

Dean MacQuigg reported briefly on the Civil Defense meeting in Washington, D. C. He stated that there was general public apathy regarding the preparation for an atomic bomb attack and that the consequences of such an attack, even though remote, are so serious as to make it imperative that careful advance planning be undertaken throughout the entire country. Professor Carson and President Dawson both spoke of specific planning which had been undertaken in their areas of the country. It was emphasized that industrial targets would

probably be the first objective of an enemy attack. The suggestion was made that an article be prepared for the JOURNAL outlining the preparations which were being made in some of the areas where advanced planning had been undertaken.

Committee on Teaching Aids

Professor Muhlenbruch reported on the progress of the Committee on Teaching Aids and stated that $4600 had been collected from industrial sources to defray the expenses of this committee and that an attempt would be made to get additional funds. He stated that reviewing committees had been appointed in several curricular areas and the review work would start in the near future.

Committee on International Relations

Dean Woolrich reported briefly on the International Night Program and the Commission on Engineering Education to Japan.

He also stated that there was need for getting information to our government and to agencies which are advising foreign students on schools in this country, since most of these agencies send engineering students to a relatively few colleges which they know about, to the exclusion of many other good engineering colleges in this country.

He also raised the question as to whether or not the ASEE should request a representative on UNESCO. He pointed out that our Society had a representative several years ago, but that our membership was on a rotation basis. The question was raised as to whether or not the ASEE should not request a continuing membership in UNESCO rather than a rotational membership. It was recommended that Deans Woolrich and Croft cooperate in the preparation of a specific proposal to be presented to UNESCO, requesting a continuing membership of the ASEE.

* * * * * *

A meeting of old and new members of the General Council was held at Michigan State College, East Lansing, Michigan on Friday morning, June 29, 1951. Those present included: F. M. Dawson, *President,* H. H. Armsby, A. B. Bronwell, L. E. Grinter, G. A. Rosselot, C. L. Skelley, F. E. Terman, S. C. Hollister, J. H. Lampe, Thorndike Saville, C. J. Freund, R. T. Landon, M. P. Capp, L. D. Jones, W. W. Dornberger, J. McKeon, H. W. Barlow, W. H. Carson, C. E. Bennett, G. B. Hoadley, W. Allan, H. A. Bolz, H. P. Adams, L. O. Stewart, F. J. Lewis, C. O. Harris, W. P. Kimball (visitor), T. H. Morgan, E. R. McKee, H. K. Justice, W. A. Koehler, C. A. Brown, H. R. Beatty, S. E. Winston, T. G. Miller, M. T. Ayers, H. H. Wheaton, L. G. Miller, G. K. Palsgrove, B. Robinson, H. C. Spencer, E. W. Lehmann, D. Hunt, E. Laitala, E. C. Clark and B. Bowen.

The President announced the following actions taken by the Executive Board at its meeting on June 27, 1951. Details of these actions are given in the Executive Board Minutes.

1. The Board approved the request of the Milwaukee School of Engineering to form a Technical Institute Branch.
2. The Board authorized the appointment of a committee to develop the possibility of getting more Associate Institutional (industrial) members.
3. The Board voted to discharge the Committee on Industrial Safety, Hygiene and Fire Prevention at the suggestion of the Committee Chairman.
4. The Board authorized the appointment of a new Committee on Civil Defense.
5. A committee was authorized to study the problems of college and university contract relations with the Federal Government.

ECRC Resolution

The ECRC resolution to form a committee to study college and university contractual relations with the Federal Government, as modified by the Executive

Board on June 27, was read to the Council.

Centennial Stamp for Engineering

It was moved and passed that the recommendation of the Executive Board to endorse the issuance of a Centennial postage stamp be accepted by the Council.

Unity of the Profession

The Secretary read the recommendation of the Executive Board at its meeting on June 27, respecting the Society's desire that any Unity of the Profession Organization should permit the Society to participate without changing its membership qualifications. The Council voted to accept the resolution and to have the President appoint a committee to study the problem and formulate specific proposals. This committee is to report back to the Council at its next meeting in the fall.

Participation in UNESCO

The following resolutions submitted by the Committee on International Relations was passed:

"Whereas engineering education is one of the most essential factors in the upbuilding of any national economy, and Whereas the American Society for Engineering Education represents the united organization of education in all of the branches of engineering, including civil, mechanical, electrical, mining, chemical, aeronautical, architectural, ceramic, petroleum, industrial, geological and agricultural instruction and research—and Whereas the present plan of occasional representation on UNESCO is entirely unfruitful of sustained aid to its program—Be it resolved that we request the authorities of UNESCO for the appointment of a continuing representative on the UNESCO Councils from the American Society for Engineering Education—And that the Council of the American Society for Engineering Education authorize the President to actively pursue and negotiate with UNESCO to make such continuing representation possible."

Registration Fee

The following recommendation of the Executive Board at its meeting on June 27, regarding charging of registration fees at Annual Meetings, was passed by the Council.

"The host institution is to submit to the Secretary of the Society a budget showing their anticipated income and expense and also indicating the anticipated deficit. The President and Secretary of the Society are then authorized to set a registration fee to be charged by the Society, this fee not to exceed $4.00 per person, with no additional charge for other members of a family. The host institution will be reimbursed out of this fund for such items in the deficit as appear appropriate to the President and Secretary. Any amounts collected through this registration fee in excess of the expenditures authorized will be the property of the Society and will be set up in a reserve fund for future conferences. This registration fee should be charged by the Society, although the host institution may collect the money at the time of registration and report to the Society the amount collected."

Universal Military Training

A motion that the Manpower Committee be authorized to make a statement of policy on universal military training was discussed and passed.

Life Membership

The following persons meet all of the requirements for life membership in the Society and the Council voted to grant them life membership: H. Baum, G. W. Case, W. W. Carlson, M. I. Evinger, F. M. McCullough, L. O'Shaughnessy, E. B. Paine, J. E. Perry, J. R. Price, J. C. Rathbun, C. A. Schneider, E. B. Smith, W. R. Spencer, A. C. Stevens, V. T. Stewart, H. Tilghman, P. H. Underwood.

Resignations

The Council voted to drop the members of the Society who were delinquent more than two years in dues.

English Division Summer School

The English Division requested permission to hold a Summer School two days preceding the Annual Meeting in June, 1952. The matter was referred to the Vice President in Charge of Instructional Divisions for consideration.

Other Business

A comment was made that several members of the Society have expressed the desirability of providing a better outlet for the expression of opinions to the General Council and Executive Board. The matter will be placed on the agenda for the next Executive Board meeting.

Appreciation to Retiring Officers

It was moved that the Council express their deep appreciation for the excellent service of the retiring officer. Motion passed.

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

College Notes

Jess Harrison Davis, president of Clarkson College of Technology, has been elected to succeed Harvey Nathaniel Davis, (no relation) as president of **Stevens Institute of Technology.** The new president is the fourth in the 81-year history of the college and will assume his duties September 1, 1951, according to Willis H. Taylor, Jr., Chairman of the trustees. The new president has had a varied and distinguished career as an engineering educator and industrial consultant. He was graduated from Ohio State with a degree in science in 1928 and received his master's degree there in 1933. In 1949 he received the degree of doctor of science from St. Lawrence University. His industrial career has included service with Ohio Bell Telephone Company, Alabama Power Company, American Locomotive Company, and Foster Wheeler Corporation. He has served as consulting engineer for Hydraulic Controls, Inc., New York Air Brake Company, D. M. McBean, and De Wolf Furnace Corporation. He is presently on the board of directors of the Niagara Mohawk Power Corporation. The career of Dr. Jess Davis as an educator started in 1929 when he went to Clarkson College as an instructor in mechanical engineering. By 1940 he became a full professor; in 1946, dean of administration; and he was made president in 1948. During a two-year interval, he served as professor and head of the department of mechanical engineering at the University of Louisville's Speed Scientific School.

Reed College, of Portland, Ore., has associated itself with **Rensselaer Polytechnic Institute** in offering scientists and engineers a broader basis of general education than is obtainable in the usual four-year course. Reed is the twelfth center of the liberal arts to join the program with Rensselaer, but is the first Pacific Coast college to participate. Under the plan students may take three years of liberal arts work at Reed, with emphasis on basic sciences and mathematics, before entering Rensselaer for two additional years of concentrated work in a selected field of science or engineering. Five years of satisfactory progress will earn degrees from both institutions.

Fifty-Ninth Annual Meeting
American Society for Engineering Education

The Fifty-ninth Annual Meeting of The American Society for Engineering Education was held at Michigan State College, East Lansing, Michigan, June 25–29, 1951. Over 1600 members and guests registered. Three general sessions and approximately 70 conferences of Councils, Divisions and Committees were held. F. M. Dawson, Dean of Engineering, State University of Iowa, and President of the Society, presided.

The first general session on Tuesday morning was sponsored by the ECRC and was presided over by Vice President G. A. Rosselot. Dr. E. A. Walker, Executive Secretary of the Research and Development Board, spoke on "The Nation's Balance Sheet in June, 1951," and Dr. A. F. Spilhaus, Dean of Engineering at the University of Minnesota, spoke on "Research and Development: The Nation's Potential in Educational Institutions." The concluding speaker was Dr. A. A. Potter, Dean of Engineering at Purdue University, who gave an address on "National Science Foundation Developments."

The second general session was held on Wednesday morning and was presided over by Dr. H. H. Armsby, Vice President of the Society, who introduced Dr. J. A. Hannah, President of Michigan State College, whose address was entitled "Lustre or Glitter?" Dean F. M. Dawson followed with his Presidential Address, "Engineering Education—A Bridge Between Ignorance and Understanding." Secretary A. B. Bronwell then presented his yearly report.

The Nominating Committee, represented by C. E. MacQuigg, presented the following slate of Officers. Upon motion, they were unanimously elected.

For President, one year, S. C. Hollister, Cornell University;

For Vice President in Charge of General and Regional Activities, two years, M. M. Boring, General Electric Company;

For Treasurer, one year, C. L. Skelley, Macmillan Company.

The ECAC elected Dean J. H. Lampe, Dean of Engineering, North Carolina State College, as Vice President of the ASEE and Chairman of ECAC. The continuing Vice Presidents are G. A. Rosselot and L. E. Grinter.

The final event was a panel discussion of the Committee on Improvement of Teaching. Dr. L. E. Grinter, Vice President of the ASEE, acted as moderator. The panel members included H. P. Hammond, A. P. Colburn, J. F. Calvert. A discussion period followed.

The third general session, sponsored by ECAC, was presided over by Dean J. H. Lampe, Secretary of the ECAC. Dean Lampe expressed the thanks of the ECAC to all of the staff and those at Michigan State College who had a part in making the meeting so successful. Dr. M. H. Trytten, Director of Scientific Personnel, National Research Council, presented an address on "Present Status of the Problem of Scientific and Engineering Personnel." He was followed by Don G. Mitchell, President of the Sylvania Electric Products, Inc., who spoke on "America's Industrial Strength and Its Technical Manpower." Carey H. Brown, General Superintendent, Eastman Kodak Company, and Director of the Engineering Manpower Commission of the E.J.C., spoke on "The Engineering Manpower Commission of the E.J.C." This

was followed by a short question and answer period.

The Annual Banquet was held on Thursday evening with President Dawson presiding. He introduced the Officers of the Society and expressed thanks to President Hannah for the hospitality of Michigan State College. Dr. Hannah presented a gavel to President Dawson. The Speaker for the Banquet was Dr. H. G. Bennett, Assistant Secretary of State in Charge of Point Four, and President of the Oklahoma A. & M. College, who spoke on "Engineering Contributions to Underdeveloped Areas." The Lamme Medal was presented to Allan R. Cullimore of the Newark College of Engineering and the George Westinghouse Award was presented to Glenn Murphy of Iowa State College.

The following resolution of thanks to Michigan State College was read by Dean A. A. Potter, Chairman of the Resolutions Committee:

"The American Society for Engineering Education, and especially its members and friends attending its 59th Annual Meeting, extends to our gracious host, the Michigan State College, our sincere thanks for the very extensive and effectual efforts that have been made for our comfort and pleasure, as well as for the attainment of the professional aims and purposes of our meeting.

To President John A. Hannah, to Dean Loren G. Miller of the School of Engineering, and to Professor W. E. Libby, General Chairman of the Local Committee on Arrangements, and numerous associates and assistants especially we extend our sincere appreciation.

In the long history of the meetings and conventions of this Society, the 59th meeting at East Lansing will stand out as one of the most successful and enjoyable.

(Signed) HAMMOND
SAVILLE
POTTER"

It was moved and seconded that the Society authorize the Secretary to send greetings and felicitations to Dr. and Mrs. D. C. Jackson, who were not able to be present. Dr. Jackson was the oldest living Past President of the ASEE.

President Dawson announced that the 1952 Annual Meeting would be held at Dartmouth College in Hanover, New Hampshire during the week of June 23–27.

Officers for 1951–52 were read by President Dawson who then called the meeting adjourned.

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

ANNUAL MEETING

June 23–27, 1952

Dartmouth College **Hanover, N.H.**

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Carnegie Institute		E. B. Stavely, Pennsylvania State College
Illinois-Indiana	University of Illinois	May 17, 1952	D. G. Ryan, University of Illinois
Kansas-Nebraska	University of Nebraska	Nov. 16–17, 1951	Kenneth Rose, University of Kansas
Michigan	University of Detroit	May 10, 1952	W. P. Godfrey, University of Detroit
Middle Atlantic	Newark College of Engineering	December, 1951	S. J. Tracy, Jr., City College of New York
Missouri	University of Arkansas	April 5 or 12, 1952	R. Z. Williams, Missouri School of Mines
National Capital Area	Capitol Radio Engineering Institute	Oct. 2, 1951	W. Oncken, Jr., Bureau of Ordnance
New England	University of Rhode Island	Oct. 13, 1951	W. C. White, Northeastern University
North Midwest	University of Wisconsin	Oct. 5 & 6, 1951	K. F. Wendt, University of Wisconsin
*Ohio	Ohio State University		W. F. Brown, University of Toledo
Pacific Northwest	Seattle		T. H. Campbell, University of Washington
Pacific Southwest	Los Angeles San Francisco	April, 1952	S. F. Duncan, University of Southern California
Rocky Mountain	University of Wyoming		E. J. Lindahl, University of Wyoming
Southeastern	Clemson College		R. L. Sumwalt, University of South Carolina
Southwestern	University of Houston	April 11 & 12, 1952	H. P. Adams, Oklahoma A. & M. College
Upper New York	Clarkson College	Oct. 5–6, 1951	W. H. Allison, Clarkson College

Members of the Society are welcome at all Section Meetings

* No Date Set.

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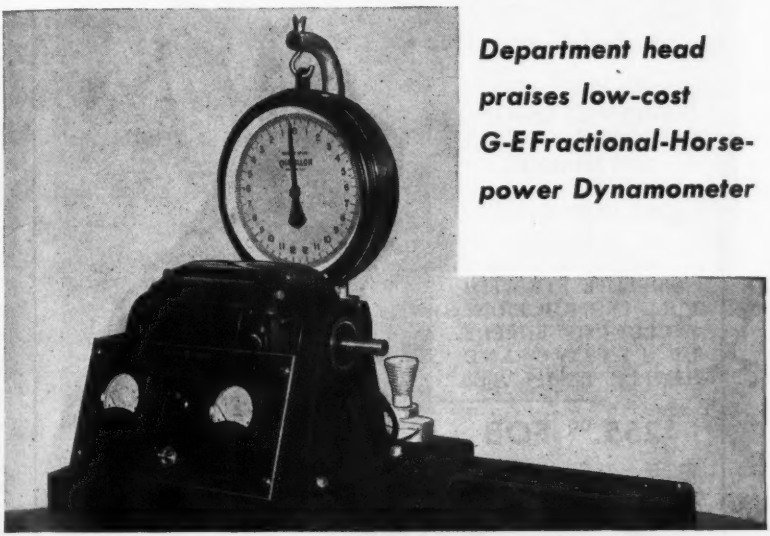

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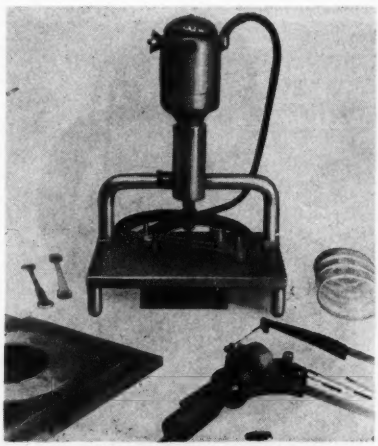

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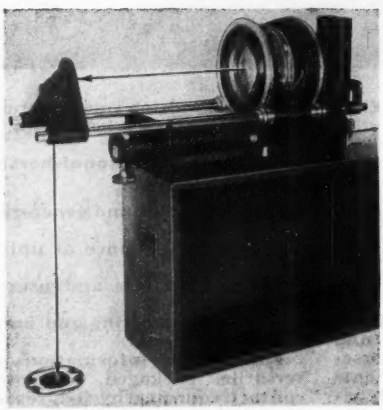

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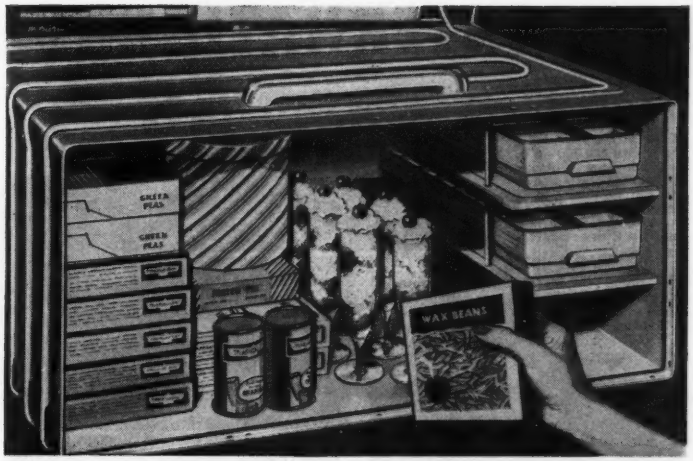

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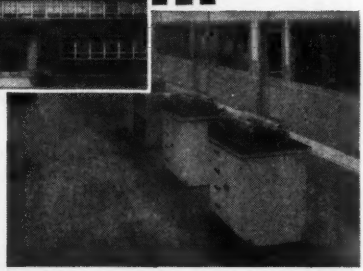
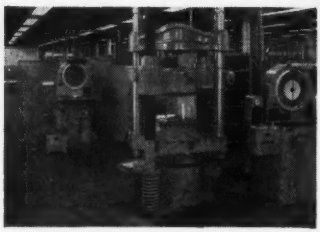


Sectional view of metallurgical laboratory, showing several laboratory rooms and a row of Baldwin-R. R. Moore and Baldwin-Sonntag testing machines.



Group of large testing machines in the laboratory. Foreground 400,000 lb. capacity Baldwin B-T-E Universal Testing Machines. Background: Baldwin 600,000 in. lb. Torsion Testing Machine.

Research worker setting up a product component in a Baldwin B-T-E Universal Testing Machine.

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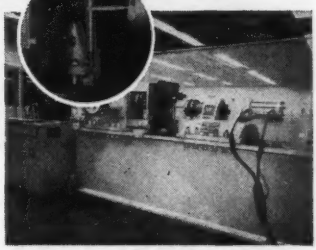
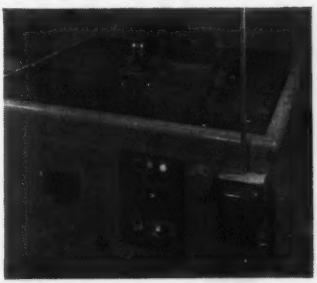
the key-way. A switch to alloy steel, plus heat treatment to improve physicals, eliminated this weakness . . . but failures occurred at the center of the weld metal. Next projected step called for an increase in size of shaft—which would involve major design changes, increased machining and added material. The problem was then turned over to Manufacturing Research.

Loads were applied to various specimens, and stress concentrations plotted. Test pieces are shown above. From left to right, (1) field failure of original design. (2) Original design tested in Baldwin SF-20-U machine. Failed at junction of shaft and weld. (3) Test shaft machined from forging, leaving extra metal on base. Failure occurred at bearing shoulder. (4) Experimental shaft with ¼" radius at flange and ⅛" radius at collar. Failed in weld after 500,000 cycles. (5) Present design. Stress at bearing shoulder eliminated by equalizing diameter at both sides of collar and distributing junction stress with large radius. Design failed after 2,020,000 cycles. Problem solved without adding extra material, or altering other machine components.



Baldwin-Sonntag SF-20-U Fatigue Machine, and (insert) test set-up to apply simulated service test to drive shaft. Final design withstood over 2,000,000 cycles before failure.



Baldwin-Sonntag Fatigue Testing Machine . . . one of several in the laboratories.

Literature on any of the Baldwin Testing Equipment mentioned will be sent on request. Just write, indicating your particular interest.

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The illustration of the transformer tank at the left shows the effectiveness of the new finish. After 1000 hours of continuous exposure to corrosive salt-water spray, it is still bright and shiny, while the tank at the right, coated with standard finish, fell victim to the salt-water attack. The new finish is expected to provide the same results when exposed under all climatic conditions including sub-zero cold, desert heat and harmful sun rays.

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